



United States Department of the Interior

U.S. GEOLOGICAL SURVEY Biological Resources Division

Midcontinent Ecological Science Center 4512 McMurry Avenue Fort Collins, Colorado 80525-3400

August 26, 1998

Charley Chandler
U.S. Fish and Wildlife Service
Division of Environmental Contaminants
4401 North Fairfax Dr., MS 330
Arlington, VA 22203

Dear Charley,

Please find enclosed a copy of the report that you recently requested. The report is entitled "Testing Air Quality Monitoring Methods in the Alaska Maritime National Wildlife Refuge's Tuxedni Wilderness Area (Chisik Island)." The study was one of several pilot projects initiated in 1993 as part of the Biomonitoring of Environmental Status and Trends (BEST) Program. This project, along with the others initiated in 1993, was supported solely with BEST funding.

If you have any questions about this or other BEST projects, please contact me at (970) 226-9484.

Sincerely,

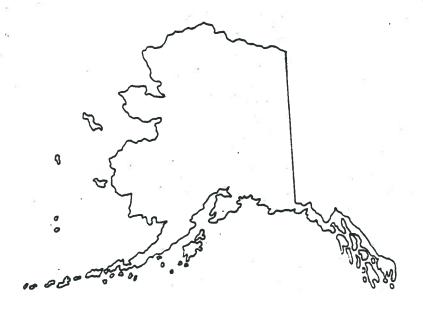
Jim Coyle

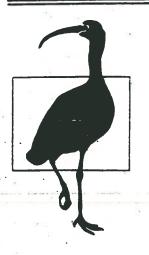
Biologist, BEST Program

Enclosure

Biomonitoring of Environmental Status and Trends Program

Testing Air Quality Monitoring Methods in the Alaska Maritime National Wildlife Refuge's Tuxedni Wilderness Area (Chisik Island)





National Biological Service Ecosystem Monitoring Division Washington, D.C.



National Biological Service Biomonitoring of Environmental Status and Trends Program

DRAFT Pilot Project Report

Testing Air Quality Monitoring Methods in the Alaska Maritime National Wildlife Refuge's Tuxedni Wilderness Area (Chisik Island)

Prepared by:
Wayne Crayton
BEST Program Field Coordinator
Anchorage, Alaska

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INTRODUCTION

Overview of BEST

The Biomonitoring of Environmental Status and Trends (BEST) Program of the National Biological Service (NBS) is a long-term, nationwide monitoring program intended to identify and understand the effects of environmental contaminants on biological resources. One component of BEST is specifically focussed on assessing contaminant threats to lands under the stewardship of the Department of the Interior. The second component of BEST focuses on describing the status and trends of contaminant effects on biological populations and the ecosystems that support them. Essential to the program's success is the identification, development and use of scientifically valid biomonitoring methods. Such methods will generate quality information that will be used by decision-makers and the public to guide local, regional and national conservation efforts.

Pilot Project Process and Objectives

This pilot addresses selected aspects of the BEST Program's overall Pilot Strategy: data collection (i.e., the suitability and effectiveness of selected field and laboratory methods) and data interpretation. Specifically, the pilot addresses 1993 Pilot Project Objective 2 [i.e., testing core methods which assist defining habitat quality on U.S. Fish and Wildlife Service (USFWS) lands].

The objectives of this pilot study are as follows:

- 1. Determine the feasibility of using selected lichens and mosses as air quality monitoring organisms in the arctic environment.
- 2. Determine the feasibility of using semipermeable membrane devices (SPMD) as a method for monitoring air quality in the arctic environment.

In addition to addressing BEST's needs, this pilot assists the USFWS with its responsibility to protect air quality-related values in Class I wilderness areas as requested by the Director, USFWS (cf. Memorandum from Director to Regional Directors, Regions 1-8, dated 17 January 1992; Subject: Air Quality Program). An earlier General Accounting Office review of wilderness areas managed by the USFWS stated that the USFWS "did not have a complete inventory of air quality-related values in any of its Class I areas" (General Accounting Office 1990). In addition, the GAO report noted that the permit review process was hampered by lack of data; this study will identify BEST's value by attempting to help rectify the problem by providing meaningful information to base management decisions upon.

BACKGROUND

U.S. Department of the Interior lands in Alaska are more likely to be contaminated by airborne contaminants rather than by contaminated surface waters and sediment transport mechanisms. For the aforementioned reasons, it is essential that BEST include methods designed to monitor (i.e. detect and measure) air quality-related impacts. The combined use of lichen/moss analyses and SPMDs may prove useful as air quality screening tools. Where found in sufficient quantity, lichens and mosses can be an ideal biological assay material for monitoring changes in plant tissue metal levels brought about by changing atmospheric chemistry (Barkman 1958, Ferry et al. 1973, Gilbert 1973, Martin and Coughtrey 1982). The establishment of element and nonpolar baselines at this time means that future collections will have a point of reference against which the magnitude and significance of change can be judged.

Semipermeable membrane devices have been shown hold considerable promise in their ability to provide time-integrated concentrations of nonpolar organics in aquatic environments, and estimate bioavailability and potential bioconcentration factors for contaminants in organisms (Huckins et al. 1993). The feasibility of the SPMD approach for in situ monitoring of airborne contaminants also appears promising, as the SPMDs mimic the uptake of contaminants via the respiration process (Petty, et al. 1993).

STUDY AREA

The Alaska Maritime National Wildlife Refuge's Tuxedni Wilderness area (specifically Chisik Island) was chosen as a study area for significant reasons. Located within Tuxedni Bay on the western shore of lower Cook Inlet, the Tuxedni Wilderness area is a Class I air quality area which requires that stringent air quality standards be met (Clean Air Act, 42 U.S. Code 7401 et seq.) (Plate 1). The Act specifically protects Class I areas against significant deterioration; however, the Tuxedni Wilderness area lies within the energy-rich Kenai region and is about 50 miles southwest of increased activities (Plate 2) that are related to oil and natural-gas extraction, refinement, transportation, and combustion that potentially threaten the pristine nature of the wilderness area. Because prevailing winds are from the north and northeast, pollutants may be dispersed to the southwest into the Tuxedni Wilderness Area.

Chisik Island (latitude, 60° 06-10'N; longitude 152° 33-38'W; Kenai 1:250000 USGS quadrangle) encompasses an area of approximately 5,714 acres. The island is elongated with a north-south orientation and length of approximately 6 miles. The northernmost end is about 2.5 miles wide and tapers to about one-quarter mile wide at its southernmost tip. The topography of Chisik Island is rugged. The island's principle landscape feature is a steep plateau with an overall southeasterly dip of about 15 percent and an abrupt escarpment along its perimeter. Elevation of the plateau ranges from about 100 feet on the southern tip to about 2,674 feet in the north. The island has long, cool winters and short, cool summers.

Chisik Island is separated from the mainland by Tuxedni Channel which ranges in width from 0.5 miles at its southern end and 2.5 miles at its northern end.

Vegetation on Chisik Island is dominated by Alnus crispa thickets with an understory of grasses and ferns. Talbot et al. (1992) distinguished three broad zones within the vegetation of the Tuxedni Wilderness Area: (1) forest communities of Picea sitchensis and Populus trichocarpa are major components of the lowlands; (2) broadleaf deciduous Alnus crispa thickets predominate from lower to middle elevations, and (3) microphyllous evergreen Empetrum nigrum-Cassiope stellerina dwarf shrub heaths appear above approximately 1,900 feet.

Chisik Island (and neighboring Duck Island) provide nesting sites for about 28,000 black-legged kittiwakes Rissa tridactyla, 10,000 common murres Uria aalge, 6,000 horned puffins Fratercula cornicular and smaller numbers of other sea and land birds, making it the largest seabird colony in Cook Inlet (Jones and Petersen, 1979). Little is known about the wildlife on Chisik Island. Moose and bear are rarely seen on the island. Small mammals (e.g. mice and shrews) are common. Beaver were introduced to the island but did not survive. Ptarmigan are common in the upland areas of the island.

METHODS

Because of the study area's remoteness and wilderness status, special permission was obtained from the USFWS to use helicopters and fixed wing aircraft to transport personnel and field equipment to where the SPMDs were deployed and lichen and moss were collected. Field work was conducted between June and August 1993.

Previous investigations of the lichen flora of the Tuxedni Wilderness area (Talbot et al. 1992) showed that fruticose lichens are most abundant in the alpine zone (above 2,000 ft). It was at this approximate elevation that ten samples of each of the following species were collected:

lichens - Cladina rangiferina; Cladina stellaria; Cladonia uncialis; mosses - Pseudoleskea baileyi; Rhytidiopsis robusta.

Exact sampling locations were determined using a hand-held Global Positioning System (GPS) receiver and mapped using GIS capabilities (Plate 3).

Plants samples were collected using stainless-steel shears while wearing rubber gloves as a precaution against contamination from handling. Each plant sample consisted of about 50 grams of plant material and was stored in cloth bags and air dried. Samples were shipped to the Branch of Geochemistry, U.S. Geological Survey, Lakewood, Colorado, where they were washed using the method of Jackson et al. (1985). The cleaned material was oven dried at 40° C for 48 hours. Approximately 20 grams of material was then pulverized in a

stainless steel blender and about 10 grams of dry, ground material was ashed in glass crucibles in a muffle furnace. Ashing occurred over a 22 hour period; the temperature was raised incrementally for the first 10 hours and then held at 500° C for 12 hours before being allowed to cool. Table 1 lists the methods used to determine the elemental concentrations in the collected lichen and moss samples.

Soils were examined in the field during June 21-28, 1993, with a shovel and hand auger and described by genetic horizon to a maximum depth of five feet. Holes were dug along transects that crossed each of the major map units and detailed soil descriptions were obtained. The relation of soils to vegetation and topography was observed along the transects and used to mark boundaries between soil map units on an aerial photograph. Site characteristics such as slope, slope length, drainage, landform, and vegetation were taken at each hole. Soil properties observed included color, texture, structure, root abundance and astribution, rock fragments, soil reaction, and horizon topography. Samples from 11 typical profiles were collected for comprehensive laboratory analysis.

Five 68-inch-long SPMDs were deployed on Chisik Island (elevation, 2,500 feet; latitude, 60° 09.453'N, longitude 152° 36.354'W) between June and July 1993 (Plate 3; Photograph 1). As a positive control, five SPMDs were deployed in metropolitan Anchorage (Photograph 2). Each SPMD contained two grams of neutral lipid and was suspended in the air for 28 days. Following retrieval, the SPMDs were shipped to the National Biological Service's Midwest Science Center where they were processed (i.e., dialyzed, subjected to high resolution gel permeation chromatographic cleanup and ampuled) and forwarded to the Mississippi State Chemical Laboratory (via the National Biological Service, Patuxent Analytical Control Facility) for analysis of nonpolar organic compounds. Performance evaluation materials (PEM), field blanks, a laboratory process blank and a SPMD control were analyzed as part of the quality control procedures sample set. The PEMs consisted of 30 ug of each priority pollutant PAH in 5mL of hexane and 10 ug of Aroclor 1242, 1248, 1254, and 1260 in 5mL hexane.

RESULTS AND DISCUSSION

The soil and vegetation information obtained during this pilot contributes to the necessary task of characterizing the study area. Site characterization quantifies biotic and abiotic factors so that changes in vegetation species and communities due to airborne contaminants can be reasonably separated from other environmental causes (Stolte et al., in USDA, 1993).

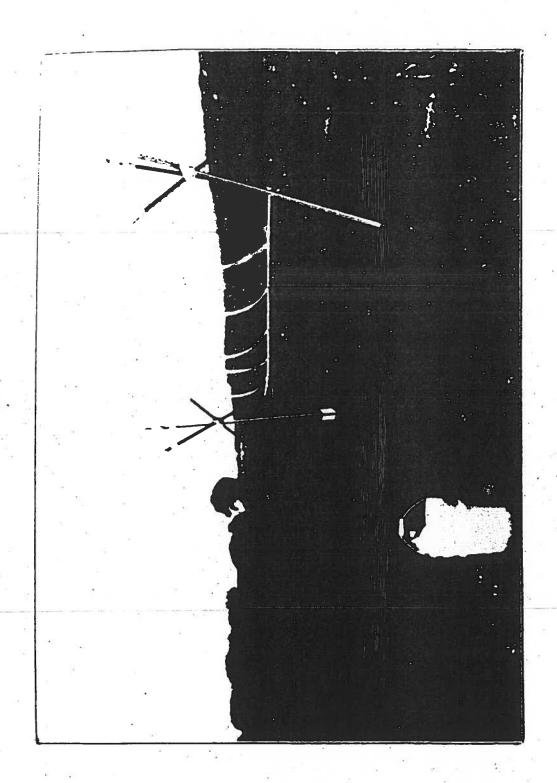
Vegetation and Soil Mapping

A total of 290 vascular plant species (279 native, 11 introduced) have been identified in the Tuxedni Wilderness Area (Appendix A). Several distinctive soil (Plate 4) and vegetation (Plate 5) relationships can be made for landforms (plateau, escarpments, alluvial fans, beach terraces) of the island (Appendix B). The primary study area lies on the island's broad

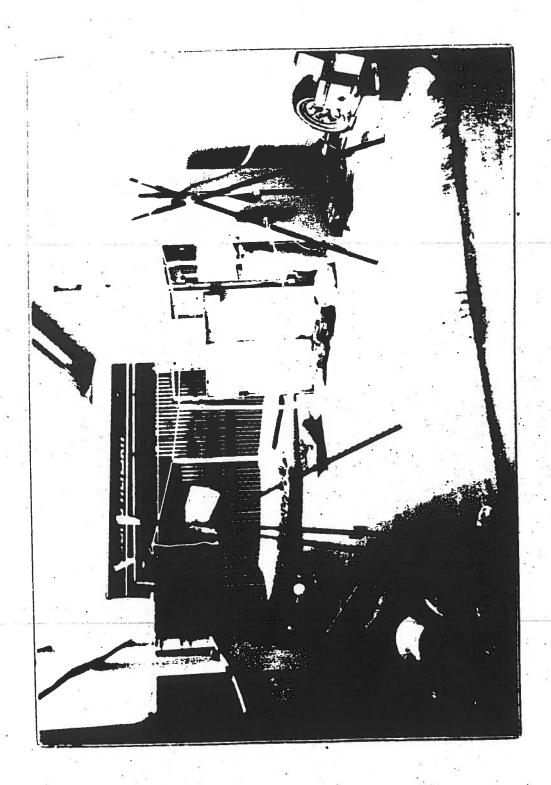
Table 1. Analytical methods used to determine elemental concentrations in collected lichen and moss samples collected from Chisik Island, June and July 1993.

Analytical Method	Determination Limit	Variables		
Continuous-flow	0.1 ppm	As, Se		
hydride generation	0.1 ppi	As, oc		
	3° .	21 4		
Inductively-coupled	2.0 prm	Ag, Cd, La, Li,		
argon plasma optical		Mo, Ni, Sc, Sr,		
emission spectroscopy		V, Y		
	0.05%	Al, Ca, Fe, K,		
	1.0	Mg, Na, P, Ti		
7085 E.O. E.	1.0 ppm	Ba, Be, Co, Cr,		
	4.0 ppm	Cu, Yb Ce, Ga, No, Mn,		
	4.0 ppm	Nb, Nd, Pb, Th,		
		Zn		
	8.0 ppm	Au		
	10.0 ppm	Bi .		
a set	20.0 ppm	<u>S</u> n		
e ¹⁰⁰ ± 1	40.0 ppm	Ta		
	100.0 ppm	U		
977				
Cantinuous flow	0.02 mm	Hg		
Continuous-flow cold vapor	0.02 ppm	116		
Combustion-IR	0.05%	S		

^{*} Analyses performed by the U.S. Geological Survey, Branch of Geochemistry, Lakewood, Colorado.



Photograph 1. SPMD deployment on Chisik Island.



Photograph 2. Spmd deployment in metropolitan Anchorage.

sloping plateau, which is the most extensive landform on the island and comprises about 75 percent of the land area. The plateau and subalpine plateau portions are mantled with volcanic ash and loess (i.e. fine-grained wind-deposited material, dominantly of silt size) about two to three feet thick over bedrock and occasionally glacial till. Alder scrub and mixed alder-salmonberry scrub vegetation dominate at lower elevations. Intermediate elevations have a more subalpine characteristic including large bluejoint grass-herbaceous meadows and Volcanic Ash Soils interspersed between areas of alder scrub and Dark Volcanic Ash Soils. Hummocky Alpine Soils, consisting of heath and willow hummocks, predominate above 1,900 feet. These features are a product of freezing and thawing. Shallow Alpine Soils occur adjacent to the plateau edge, have thin volcanic ash mantles that are typically less than 1.5 feet thick, and have lichen alpine tundra vegetation. Winter winds remove snow cover from these soils encouraging deep annual frost penetration and reducing effective precipitation. The lichen cover contributes little organic matter to the surface soil layers.

Soil, Lichen and Moss Chemical Analyses

Soil chemistry data (Appendix B) indicate that the shallow alpine soils (which support lichen and moss) are characteristic of high volcanic ash parent material which includes high organic carbon content, very high water capacities, high levels of phosphorus fixation and pH dependent cation exchange capacities.

Laboratory analysis of lichen and moss samples collected from Chisik Island's alpine tundra are summarized in Appendix C. Baseline information for the vegetation species was calculated on the dry-weight basis. In general, element concentration levels follow the progression: lichen < mosses. Thirty-two elements were detected in moss samples while 28 were detected in lichen samples. All element concentrations in lichens are particularly low compared to reported values (Crock et al. 1992). Moss concentrations, although continually higher than lichen concentrations, are not representative of an area adversely impacted by contaminated airborne particulates. However, one copper value (68 ppm) reported in a single moss sample is considered high and indicative of an area possibly influenced by airborne contaminants.

Since-lichens lack stomata and have no control over gas exchange, they are responsive to changes in their physical and chemical environments. There is also some evidence that lichens respond to changes in their host substrates (Prussia and Killingbeck 1991). Wetmore (1983) suggests that a preliminary indication can be obtained for the air quality of an area by studying the lichens present in an area with reference to their sensitivity to sulfur dioxide. Twenty-one species of lichen on Chisik Island have been categorized in 5 sulfur dioxide-related sensitivity classes (Talbot, 1988): Only one, (Cladina stellaria), was chemically analyzed in this pilot. Based on the small sample size in this pilot, preliminary evidence indicates that there is no adverse air quality (SO₂) impact on Chisik Island, which is supported by previous studies conducted on the island (Talbot, 1988).

Semipermeable Membrane Devices

Quality Control Samples:

The results of the quality control samples, as determined by the contract laboratory are summarized in Appendix D (Tables 1 and 2). In general the results are acceptable. The value of Aroclor 1248 is somewhat high (130% recovery) but permissible. In the case of the PAHs, the reported values are acceptable. With the exception of HCB (which is a MSC laboratory contaminant, no blank sample contained residue greater than the stated detection limits of the contract laboratory (i.e. 0.25 uh/g for PAHs and 0.004 ug/g for PCBs and OCs. Based upon the results of the analysis of PEMs and the blanks, we believe the samples were deployed, retrieved, processed, and analyzed without introducing extraneous contamination. Consequently, the SPMD sample data appear to be representative and acceptable.

Field SPMD Samples:

The analysis of the five SPMD samples from Chisik Island revealed anthropogenetic contaminants to be present in only one sample. The residues; benzo(a)pyrene (0.35 ug), benzo(b)fluoranthene (0.28 ug), benzo(e)pyrene (0.30 ug), benzo(k)fluoranthene (0.30 ug), and perylene (0.39 ug) were all very low and near the stated detection limit. Consequently, the Chisik Island site does not appear to have been impacted by PAHs or other anthropogenic contaminants during the exposure period. In contrast to the Chisik Island site, contaminant residues were present in all five SPMD samplers located in Anchorage (Appendix D, Table 3). Alpha-BHC and gamma-BHC were present in four of five samplers with a mean value of 0.010 ug/SPMD and 0.017 ug/SPMD, respectively. No PCB residues were detected in these samplers. The PAH values presented three are somewhat variable but appear to verify the presence of PAH residues. Moreover, the residue found in these SPMDs are indicative of bioavailable residues (i.e. by respiration).

CONCLUSIONS

This project facilitated a partnership between USFWS efforts to document the botanical resources of Chisik Island and establish an analytical chemistry baseline in local lichen/moss communities for future reference and BEST Program efforts to identify potential methods for monitoring the presence and effects of airborne contaminants. In addition, a comprehensive soil and vegetation inventory of Chisik Island was performed in cooperation with the USDA's Natural Resources Conservation Service, U.S. Geological Survey and USFWS.

Semipermeable membrane device data demonstrate their utility to sequester airborne anthropogenic contaminants. Further, the SPMDs were successfully used to define the absence of detectable airborne contaminants on Chisik Island and the presence of typical anthropogenic contaminants in the air at the Anchorage site. Thus, the SPMD technique can be employed in ambient air monitoring activities. Further research is required to develop the

algorithm(s) necessary to estimate actual air concentrations. This research would involve controlling laboratory studies to define the kinetics of uptake of contaminants by SPMDs and additional field deployment of the SPMDs.

The lichen/moss analytical data and soil chemistry profiles provide a valuable baseline for future comparisons. When sufficient data is available, this baseline data can be compared with more current data to determine whether correlations exist between data patterns and non-pollution physical and biological factors. Such correlations may provide a basis for determining to what extent these factors (i.e. elemental content and soil chemistry) influence lichen species diversity, distribution and abundance. Regression analyses might be used for studying trends over time and space. If the appropriate experimental design is used and the statistical assumptions are met, various parametric or non-parametric univariate approaches may be useful as well. The ultimate challenge for the BEST Program in establishing an air quality monitoring component is developing the capability to economically collect and interpret site characterization data and distinguish d...a patterns that can be attributed to airborne contaminants.

ACKNOWLEDGMENTS

This pilot study represents the cooperative effort of staff from the National Biological Service, U.S. Fish and Wildlife Service, U.S. Soil Conservation Service, and U.S. Geological Survey. Steve Talbot's (USFWS, Refuges and Wildlife, Anchorage, AK) botanical expertise and overall enthusiasm for this pilot study was critical and greatly appreciated. Mark Clark (USDA, Natural Resources Conservation Service, Palmer, AK) conducted the soil investigation and prepared a final report which will be used for future assessments. Tom Jennings (USFWS, Habitat Conservation, Anchorage, AK) provided geographical information system assistance, advice, and provided the repat's color plates. Jim Crock (USGS, Geophysical Branch, Lakewood, Colorado) chemically analyzed the lichen and moss samples and tabulated the data. Special thanks are extended to Jim Petty (NBS, Midwest Science Center, Columbia, MO) for his advice, assistance, and final report on the possible use of semipermeable membrane devices in air quality monitoring studies. Nancy Tileston (USFWS, Librarian, Anchorage, AK) was very instrumental in obtaining difficult-to-find references. And finally, I thank John Martin (USFWS, Alaska Maritime National Wildlife Refuge) for allowing us to use helicopters on Chisik Island to transport gear and personnel to what would be otherwise inaccessible locations.

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Appendix A

Botanical Reconnaissance of Tuxedni Wilderness Area, Alaska

Steve Talbot
U.S. Fish and Wildlife Service
Refuges and Wildlife
Anchorage, Alaska

abstract

BOTANICAL RECONNAISSANCE OF TUXEDNI WILDERNESS AREA, ALASKA

Stephen S. Talbot¹, Sandra Looman Talbot¹, and Stanley L. Welsh²

ABSTRACT. -- The vascular flora of two small maritime islands, Chisik and Duck Island (2,302 ha), comprising Tuxedni Wilderness located in western lower Cook Inlet, Alaska, was recorded to determine species composition in an area where few previous collections had been reported. The field study was conducted from sites selected to represent the totality of environmental variation within Tuxedni Wilderness. Data were analyzed using published reports to compare the vascular plant distribution pattern of Tuxedni with the northern hemisphere, North America, and Alaska..

A total of 290 species were identified, 279 native and 11 introduced. The annotated list of species for Tuxedni Wilderness expands the known range for many species filling a distribution gap within Hultén's Central Pacific Coast district.

¹ U.S. Fish and Wildlife Service

¹⁰¹¹ East Tudor Drive

Anchorage, Alaska 99503

² Life Science Museum and Department of Botany and Range Science Brigham Young University

Provo, Utah 84602

Compared with vascular plant distribution in the northern hemisphere, the flora of Tuxedni Wilderness primarily includes species of circumpolar (36.6 percent), eastern Asian (22.9) and North American (20.4) distribution. The most important longitudinal distributional classes within North America consist of transcontinental species (59.9 percent) and species restricted to the extreme west (32.2). The distribution of Tuxedni species in latitudinal zones peaks in the high- and low-subarctic, gradually decreasing through the low- to high-arctic. Latitudinal zone comparison based on the Raunkiaer life-form spectrum suggests the Tuxedni flora is closest to the high subarctic zone.

Appendix B

Soil Survey Investigation

Mark Clark and Chein-Lu Ping
U.S. Department of Agriculture
Natural Resources Conservation Service
University of Alaska Fairbanks
Palmer, Alaska

Table of contines only

SOIL SURVEY INVESTIGATION

Chisik Island Tuxedni Wilderness Area Alaska

by
Mark H. Clark
Chien-Lu Ping
USDA · Natural Resources Conservation Service
University of Alaska Fairbanks

Foreword

This report describes the soils of Chisik Island, Tuxedni Wilderness Area, and provides information or their genesis and landscape setting. The soils investigation was requested by The United States Fish and Wildlife Service to complete the soils portion of a comprehensive soil and vegetation inventory.

The report contains a detailed soil map of the island at a scale of 1:24,000. Soil map unit descriptions and management information are in the section Soil Map Units. Complete descriptions of representative soil profiles, their classification, and a discussion of their formation are in the Formation of the Soils section and Appendix B.

Some terms used in this report have a special meaning in soil science and are defined in the glossary.

State Conservationist

Steven A. Probst State Conservationist Soil Conservation Service

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Appendix C

Analytical chemistry data sheets for collected lichen and moss samples.

Jim Crock
U.S. Geological Survey
Geochemistry Branch
Lakewood, Colorado

Appendix C. Elemental concentrations in moss samples from Chisik Island, June 1993.*

3/1		6.6	3				***	50 S 6 6	1.P			
Sample ID	Lab #	Al, ppm	Ca, ppm	Fe, pp	a K, ppr.	Mg, pp	m Ma, ppe	n P, ppm	Ti, ppu			
	lie lee				Mir					that was all the		arry.
PSEU BAI-8	555543	3100	6000	1400	2300	1500	850	850	110		The state of	
		41 2 3 3 3	6200	1500	1800	1600	1000	-950	120			
PSEU BAI-D	555544	3900				and the second		The state of the s	A mile			
PSEU BAI-5	555545	3300	5800	1400	1300	1400	860	620	110		· · · · · · · · · · · · · · · · · · ·	
PSEU BAI-7	555546	2900	5200	1400	2200	2400	880	730	110	- ·		
PSEU BAI-1	555547	3500	6800	1500	1600	1600	990	880	110			17
PSEU BAI-11	55554	6100	6800	2400	2000	1800	1600	860	200			T. of
		ed thanks at the con-	find our man			Water Street Street			Fre			
PSEU BAI-6	555549	4700	6400	1900	1900	1600	1200	810	150		72.45	
RHYT ROB-1	555550	4500	7100	2000	2100	1800	1400	700	160			
RHYT ROB-11	555551	6600	8500	2800	2400	1900	1900	970	210			
##							7.17.2			0.5.2		
	3.777-3.469.71											
. Sample ID	in, ppm	Ha, ppm	Ce, pps	Co, ppm	Cr, ppm	Cu, ppm	Ga. ppm	La, ppn	Li. ppm	No, ppu		
				17	. COLUMN	MAXING.		ir de y ger de j	g 245-155		4.44	· .
PSEU BAI-8	120	65	1.6	1.1	1.1	12	0.7	0.9	0.6	<0.2		94.
PSEU BAI-D	160	46	1.5	1.0	1.2	16	0.7		0.7	<0.2	The state of the s	Part of the last
	or a management	39	1.5	0.9	THE RESERVE OF THE POST OF	11	0.5	0.8	0.6	<0.2		
PSEU BAI-5	120		Nava - Dan	All the second	1.	man	All the best words and the same				1111	7.7.1-
PSEU BAI-7	160	47	1.2	0.7	1.0	-12	0.6	0.7	0.6	<0.2		
PSEU BAI-1	170	62	1.6	0.9	1.2	20	0.7	0.9	0.7	0.2	1 20 50	
PSEU BAI-11	200	68	2.5	1.6	1.6	15	1.1	1.4	1.0	<0.3		
PSEU BAI-6	110	55	2.1	1.4	1.5	16	0.8	1.2	0.8	<0.2	safera alle e lee a	
	47-1-1	and the second	21				47		and the second of a		a in the second second	T.V.
RHYT ROB-1	260	70	1.6	1.0	1.6	24	0.9	0.9	0.9	<0.3	ter star description	33.7
RHYT ROB-11	170	84,	2.7	1.3	1,7	31,	1.3	1.6	1.2	<0.4	And price to the state of	
	Com Williams	Karla in	1 10	New York	201			A STATE OF			The state of	134
- Sample ID	Mb. ppm	Ed. ppm	Mi, pp	a Pb, pp	a Sc. ppm	Sr. ppm	V. 200	LY pps	Yb, ppu	Zn, p	7	100
					TARREST .	St. As Pres	7545					
	7	TO A TOTAL	A. A.	HAME TO THE	the state of the	A STATE OF	电力电影	一个	along the second	\$117 Burk 1	Carl Complete	4. 2.
PSEU BAI-8	<0.4 €	0.8	2.3	3.6	0.4	50	3.9	0.9	<0.1	- 21		1
PSEU BAI-D	0.5	0.5	2.9	5.2	. 0.5	47	6.3	0.8	<0.1	26	A PARTY A	1
PSEU BAI-5	0.4	0.7	2.3	5.3	. 0.4	43	4.2		<0.1	21	" TO THE PARTY	
PSEU BAI-7	0.5	0.5	1.7	3.2	0.4	42 Y	4 2 8	0.7	<0.1	22	THE TOTAL	1.11
		200				See a second	79. 7		27			14
PSEU BAI-1	0.5	8.0	3.2	5.7	0.5	5. 52	4.2	0.9	<0.1	28		2.41
PSEU BAI-11	0.6	1.0	2.3	5.5	0.7	60	6.9	****1.3	<0.2	25		11.15
PSEU BAI-6	0.5	0.9	2.7	4.4	0.6	49	5.6	11.2	0.1	22	T. W. P. 1917	T :
REYT ROB-1	<0.6	0.7	3.2	3.7	0.6	. 4 55	5.5 K	130 0.9 B	TT-<0.1	32	DINTAKE OF	2
the state of the state of the state of	- 0.7	*,1.3	2.3	4.1	0.8	68	7.0	1.6	<0.2	32	1	
RHYT ROB-11		7.			J. C. S. C. TEC.	S		DE STATE OF STATE	7.2		T.	*
E A STATE OF THE S							· · · · · · · · · · · · · · · · · · ·	10 m				150
Sample ID	As, ppm	Se. Pi	pa Hg.	ppm To	stal 8, %	Ash, t	- 2					157
						4	A A	n de		med je te v	and the second second second	V 2
PSEU BAI-8	0.2	0.4		0.05	0.11	5.0		7 2 25 70				
		100		0.10	0.12	5.6	12.74	1	ATT VEST .		4.0	
PSEU BAI-D	0.2	0.4	CALL STATE		The second second	1 1 1 1 1 E- 1	149	47577-7347				
PEEU BAI-5	0.2			0.10	0.11	4.8	700		7			
PSEU BAI-7	0.2	0.	3	0.08	0.10	5.2		14				
PSEU BAI-1	0.2	0.4	4	0.08	0.11	5.2				F. Commission		
PSEU BAI-11	0.2	0.		0.13	0.11	7.8		Harrison .		227		1.
10 Table 10		Part - S										
PSEU BAI-6	:			0.07	0.14	. 5.8	Mark Trans					1
RHYT ROB-1			• 100	0.12	0.11	7.2				0.000		1
MEYT ROB-11	0.3		4	0.11	0.12	8.8		3 -4.554.55				
				i de la composición della comp				Action 1	1 1 1 1 1	- <u> </u>		

* ppm dry-weight basis PSEU BAI - Pseudoleskea baileyi RHYT ROB - Rhytidiopsis robusta

Appendix C. Elemental concentrations in moss samples from Chisik Island, June 1993.*

	1 - 2 - 12		Kati jare,			the same of the same			10.0	Fei (Fe (Fe)
Sample ID	Lab #	Al, pps	ca, p	pm F	e, ppm	K. ppm	Mg, pp	m Ma, ppm	P, ppm	Ti, ppm
		.	z		1			Arabin		
RHYTROBU-A	555269	6800	9900		3200	2000	2300	2000	630	250
RHYTROBU-B	555270	6300	8200	300	2700	3300	2100	1700	900	210
RHYTROBU-C	555271	8000	7830		3200	2900	2100	1800	790	240
RHYTROBU-D	555272	6100	7200		3000	3100	/2100	1700	770	230
RHYTROBU-5	555273	3900	7700		L700	2500	2000	1200	830	130
RHYTROBU-6	555274	5900	8680		2600	3600	2300	1600	1090	200
RHYTROBU-7	555275	4400	8600		800	3300	2000	1200	990	150
RHYTROBU-8	555276	4700	6000	1	800	2600	1500	1100	700	130
PSEUBAIL-A	555277	4900	6400	1	200	2600	1700	1300	770 -	170
PSEUBAIL-B	555278	3900	6700	3	600	2000	1800	1100	950	130
PSEUBAIL-C	355279	4300	5900	1	700	1900	1600	1000	810	140
Comment of the	75 XX			1.15	11.116.6		dayayaya te u			
Sample ID	Mn. ppm	Ba, ppm	Ce, ppm	Co. Pps	Cr. p	pm Cu, j	opm Ga, ppe	La, ppm	Li, ppm	Mo, ppm
agillaria e di aviani		Links			and the second	dual order us or	Manager and restricts			
RHYTROBU-A	230	88	2.8	2.4	2.0	68	1.2	1.7	1.3	<0.3
RHYTROBU-B	260	76	2.7	2.4	to the design the stage of the stage	15	1.2	1.6	1.2	<0.3
RHYTROBU-C	230	72	.3.1	3.0	1.9	15	M-1/1	1.9	1.3	<0.3
RHYTROBU-D	180	W. 66	2.2	1.4	2.2	11	1.2	320.0	1.2	<0.3
RHYTROBU-5	160 %	47	1.3	0.8	1.3	14	0.8	0.8	0.81	<0.2
BHYTROBU-6	400	86	2.1	1.6	1.9	14	1.2	1.3	1.0	<0.3
RHYTROBU-7	400	73	1.6	1.6	1.2	L . L 15	0.8	2.00 1.0	0.9	<0.2
	120	64	1.9	1.5			0.8	1.1	0.8	<0.2
REYTROBU-8	200	64	2.2	1.6		100	0.8	1.3		<0.2 - 12-100 -
PSEUBAIL-A	220	90	1.8	1.3			0.7	1.0	0.8	<0.2
PSECBAIL-B	AZ110 / 3	48	2.2	******	761.4	16	0.7	2 1.4	0.8	0.2
PSEUBAIL-C				1 (22.5	1004		in the co		vitting in a second	
Sample ID	lib. ppu	Ed. ppu	Mi, ppe	Pb.	ppa 8		Sr. ppa V	ppm Y. pr	m Yb, ppm	Za, ppm
		1.1				and the second	La Caralla			
RHYTROBU-A	0.8	1.2	3.9	5.0		0	88	1.6	<0.2	32
RHYTROBU-B	<0.7	21.3	2.5	4.8		0.7	THE RESERVE TO SERVE	.5 1.5	<0.2	26
RHYTROSU-C	<0.7		2.5	5.4	100	0 9	A Follow I Some Till	.0 2 1.7	0.2	23
RELYTROBU-D	0.7	0.9	3.0	5.6	X 3-74-1	* ************************************	15. 75.	.2 . 1.3	<0.2	25
	<0.5	<0.5	2.1	4.4	L'A TIL	0.5	to the second	.7 0.8	<0.1	24
REYTROSU-5		The state of the s	2.3	3.9	THE WAY	0.8		.3 1.3	0.2	30
RHYTROBU-6	0.7	0.5	1.9	2.8	1	0.5		1.2 0.9	<0.1	32
EEXTROBU-7	A		1.9	3.2	- 1 × 1 × 1 × 1 ×	0.5		1.1	<0.1	17
RHYTROBU-8	<0.5	0.8	2.6	4.2		0.6	the state of the state of	1.2	0.1	24
PSEUBAIL-A	0.6	1.1	4.1	5.6		0.5		.7 1.0	0.1	30
PSEUBAIL-B	0.5	0.8		5.4	4.7	0.5		1.7	<0.1	21
PSEUBAIL-C	0.6	1.0	2.3		2723 200			- 10 - 10 - 10 - 10 - 10 - 10 - 10 - 10		
Sample ID	AG. 95	30,	Mar	7		S. t lei				
					7,5298		, we have		5	
REPTROSU-A	0.3	0.3	200	07	0.09	r. 7			116	
REYTROBU-B	0.2	0.4		06	0.11			17.7	W se se	
BETTROBU-C	0.3	0.4		.06	-0.10	•	1 - 1	**************************************		
REYTROSU-D	0.3	0.4		.07	0.10	8.		1		
RHYTROSU-5				.06	0.10					
RHYTRONU-6	0.2	0.1		.04	0.12			free but and		
REYTROSU-7	0.2	TL 5.3	the same of the same	.04	0.12		Andrew State of the open	.##¥ (L.)	Jack to	
RHYTROSU-8	0.2	· 0.1		.04	0.10					
PREUBAIL-A	0.2	0.4		.05	0.11	5.		wid y 12		
PSEUBAIL-8	. 0.2	į 0.4		.06	y 0.11		Section 1	745	the state of	
PSEUBAIL-C	1.9	0.1	0	.05	0.13			73.63 X C	1 E 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	to Paping Tale

ppm dry-weight basis PSEUBAIL - Pseudoleskea baileyi RHYTROBU - Rhytidiopsis robusta

Elemental concentrations in moss samples from Chisik Island, June 1993.*

	The state of the s	1.000	The same of the sa			
	AL. & Ca. V	Fe, t	K to Mg.	t Ma t	P, % Ti. %	
Sample ID Lab #	Al, & Ca, &				4.5	
			4.5 3.0	71.7	1.7 0.21	
PSEU BAI-8 555543	6.1 12	2.8			1.7 0.21	September 1 Maria Principal Control
PSEU BAI-D 555544	7.0 11	2.7	3.3 2.9	1.8		The section of the state of
1000 011-	6.8 12	3.0	. 2.83.0	1.8	1.3 0.23	
• • • • • • • • • • • • • • • • • • • •		2.7	4.3 2.7	1.7	1.4 0.22	in the state of th
PSEU BAI-7 55551			3.1	1.9	1.7 0.22	And the second s
PSEU BAI-1 555547	6.8 13	2,9		2.1	1.1 (0.25	A STATE OF THE STA
PSEU BAI-11 555548	7.8 8.7	3.1	2.6 2.3	2,50	1.4 0.26	
PSEU BAI-6 555549	8.1 11	3.3	3.1-2-2.7	2.0	The second of th	
RHYT ROB-1 555550	6.3 9.9	2.8	2., 2.5	1.9	the same of the constitution of the same of the	
	7.5 9.7	3.2	2.7 2.2.2	2.2	1.1 0.24	
RHYT ROB-11 555551			V			
		<i>J</i>		ppm Ga, I	orm La, ppm Ld.	ppm No, ppm
Sample ID Mn. ppm	Ba, ppm Ce, p	pm Co. I			The second second second	
		1.	31.15		17	
PSEU BAI-8 2300	130031	_ / 22 .	22 22 2	40 13	. To have a real make that desired	the territory of the second of
	830 26	17_	22 10 22	80	.15 .15	and a - Market Confidence and Confidence
	810 31	18	23 23 2	20 11	17	St Elizabeth
PSEU BAI-5 2600	and the second second	14	20 20 2	30 12	13 13	The second second
PSEU BAI-7 3100	910 23	- W. S. Charles, Street, P. Land St.	23 23 3	and the same and the	18	
PSEU BAI-1 3200	1200 31	18			18	at the same of the
PSEU BAI-11 2600	870 32	21,	A THE RESERVE OF THE PARTY OF T	A STATE OF THE STA		The state of the s
PSEU BAI-6 1900	940 36	24	26 26 2	80 13	TEL FOREST	The state of the s
	970 22	-14	- v.y. 22 meet 3	30 2 2 23	of many dark many and a sign man with the land of	the same of the sa
	960 31	15	19 1	50	18 1	A Company
EHYT ROB-11 1900	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	The state of the s		1		the state of the s
			So pee Sr	ppa V. pp	m (Y, ppm Yb,)	ppa In. ppa
Sample ID Mb. ppm	Nd. ppm Hi. pp	a Pb. pp			and the second	
						2 420 226
PSEU BAI-8 <8	16 45	3 71	1 8 THE 93	And the same of Colonia of the Real		The state of the s
PSEU BAI-D 8	9 52	92	0.02	COLUMN TO A PARTY OF THE PARTY.		The state of the s
	15 47	110	9 5 00	0	. 17	The state of the s
PSEU BAI-5 9		61	L oc	0 44 81	13	2 430
PSEU BAI-7 9		110	9 7 7 100	0 7 81	17	2 540
PSEU BAI-1 9	. 16 62	2000	The State of the State of	The state of the s	17	2 320
PSEU BAI-11 8	13 29	70		many development of the property	20	2 380
PSEU BAI-6 8	15 47	76	The state of the s	50		2 450 25
REYT ROB-1 <8	9 45	52	8 7	70 . 77	The second secon	The second secon
	15 26	46	9	70 79	10	and the second second second
RHYT ROB-11 \$	1-40-1-1-1					Water Company
		The feeling of	Total S. V As			\$2000年7月1日曾被自己的第三
Sample ID As. pp	a Se, ppm Ho	, ppa	The Contract of the Contract o	uneda Aribis		
		alestat yet.	10000			
PSEU BAI-8 0.2	0.4	0.05		.0		
PSEU BAI-D 0.2	0.4	0.10	- 1 - 2 - Fe - 2 - 1	.6	ostal de terrologico.	Production of the state of the
		0.10	0.11	.8		
	현존 경기를 내려왔습니다.	0.08	0.10	.2		
PSEU BAI-7 0.2		0.08		.2		
PSEU BAI-1 0.2			the series of the largest reading to	7.8		
PSEU BAI-11 0.2	0.5	0.13	于 //ex / 人,并是有特征。			
PEEU BAI-6		0.07		3.8	the state of the	
RENT ROS-1		0.12	0.11	7.2		
*	0.4	0.11	0.12	3.8	- 1. * 4. kg., * 4. .	
REYT ROB-11 0.3				an Historian		

^{*} determined on raw material, ash basis data PSEUBAI - <u>Pseudoleska baileyi</u> RHYTROB - <u>Rhytidiopsis</u> <u>robusta</u>

Appendix C. Elemental concentrations in moss samples from Chisik Island, June 1993.*

						100		•		
a ple ID	Lab #	AL, *	Ca, t	Fe, t	K. *	Mg, t	Na, t	P, *	Ti, t	
								d alimit	1. J	
RHYTROBU-A	555269	7.5	11	3.5	2.2	2.5	2.2	0.70	0.28	
RHYTROBU-B	555270	7.7	10	3.3	4.0	2.6	2.1	1.1	0.26	24 1
RHYTROBU-C	555271	8.9	8.7	3.5	3.2	2.3	2.0	0.88	0.27	
RHYTROBU-D	555272	7.4	8.8	3.6	3.8	2.5	2.1	0.94	0.28	172.5
RHYTROBU-S	555273	6.1	12	2.6	3.9	3.1	1.8	1.3	0.21	10.00
RHYTROBU-6	555274	7.5	11 /	3.3	4.6	2.9	2.0	11.4	0.26	
RHYTROBU-7	555275	6.7	13	2.8	5.0	3.1	. 1.8	1.5	0.22	
RHYTROBU-8	555276	6.7	8.6	2.5	3.7	2.2	1.6	1.0	0.19	
PSEUBAIL-A	555277	7.7	1-10	3.4	4.0	2.6	2.0	1.2	0.26	
PSEUBAIL-B	555278	7.0	12	2.9	3.5	3.2	2.0	1.7	0.23	
PSEUBAIL-C	555279	7.9	11	∠ 3.1 ·	3.6	2.9	1.9	1.5	0.25	
			SAMPY A		Alberta Co.		de oz			6. S.77
Sample ID	Mn, ppm	Ba, ppm	Ce, ppm Co	, ppm Cr	. ppm Cu,	, ⊃m. Ca., j	ppm La,	ppm Li,	ppm Mo, p	pm
		Marie Salaharan	with the state of the	Constant for the con-		liter is the second		days a New York of the To		
RHYTROBU-A	2500	980	31	27	22 79	50 13	1	9 14	<4	
REYTROBU-B	3200	930	33	29	21 1	10 14	1	9 14	<4	
RHYTROBU-Ç	2500	800	34 (33	21 17	70 15	3	1 14	<4	
RHYTROBU-D	2200	. 800	27	17	27 14	10 14	1	6 15	<4	
RHYTROBU-5	2500	730	20	13	20 22	10 12	-1	2 . 12	<4	
RHYTROBU-6	5100	1100	27	21	24 18	10 15	1	7. 13	<4	- 1
RHYTROBU-7	6000	1100	24	24	18 22	10 / 12	1	5 13	<4	
REYTROBU-8	71700	920	27	22	18 🤼 19	11	. 1	6 11	<4	
PSEUBAIL-A	3100	1000		22	22 19	13	2	1 7 14	4	
PSEUBAIL-B	3900	1600	32	23	21 25	12	1	8	<4	734 0
PSEURAIL-C	2100	890	40	20	24 30	12	. 2	5		
TOP TANK	A A Company			72 - 277						The same
Sample ID	Mb. ppm	Md. ppm	Mi. ppm Pb	, ppm S	c, ppm Sı	, ppm V,	ppm Y,	ppm Yb,	ppm Zn,	ppm
de la companya de la								Total Control		77.10
REYTROBU-A	9	13	43 5	1	1 90	10 10	18	25 <2	360	7.70
PHYTROBU-B	- , ∢8	16	30 2 70 5	1	9 87	70 9:	L 18	<2	320	
RHYTROBU-C	<8	15	. 28	0	0	10	19	2	250	
REYTROBU-D		11 💯	37 6	1	0 70	100	16	<2	310	· Barria
REPTROBU-5	<8	<8	32 6	•	8	10 7	1 12	₹2	380	174455
REYTROBU-6		. 13	30 5	0 1	0 9!	50 9	16	2	380	
REYTROSU-7	9		29 . 4	3	8 110	7:	14	<2	480	
RHYTROBU-8	<8	12	27 4	5	7 7	50 6	9 15	<2 .	240	1233
PSEUBAIL-A		17	41 6	6 1	0 8	50	7 19	2	380	$A_{i,j}(X_i)$
PSEUBAIL-B	9	14	73 10	0	9	00 8	3 17	2	530	12
PSEUBAIL-C	11	/ 18 1	42 10	0	9: 9	90 8	7 22	<2	390	
**************************************				100	Carrent Co.	1 V				2,2 344
Sample ID	As, pp	a Se, pp	Hg, ppm	Total 8	, & Ash,					
RHYTROBU-A	0.3	0.3	0.07	0.09	9.0				1070	900
RHYTROBU-B	0.2	0.4	0.06	0.11	8.2		1.0	ja jakos si		
REVIROBU-C	0.3	0.4	0.06	0.10	9.0	la e				
RHYTROSU-D	0.3	0.4	0.07	0.10	8.2				" "TI"	
REYTROSU-S	, 		0.06	0.10	6.4		W	200	a free fr	
RENTROBU-6	0.2	0.3	0.04	0.12	7.8					ojika 8 "
METTROSU-7	0.2	0.3	0.04	0.12	6.6					
REYTROSU-8	0.2	0.3	0.04	0.10.	7.0					
PSEUBAIL-A		0.4	0.05	0.11	6.4				- 7 (
PSEUBAIL-B		0.4	0.06	0.11	5.6	1				100
PSEUBAIL-C	(Mark)이 보겠어졌다. ~	0.5	0.05	0.13	5.4	-7.121	11			
	1201	100 M - 600 M - 727 M		E *:	The state of the s	9.7		50 min 10		

^{*} determined on raw material, ash basis data PSEUBAIL - <u>Pseudoleska</u> <u>baileyi</u>

Appendix C. Elemental concentrations in lichen samples from Chisik Island, June 1993,*

Sample ID	Lab #	Al. ppm	Ca, ppm	Fe. ppm	K, ppm	Mg, ppm	Ma, ppm	P, ppm	Ti,	ppm
			White Art of			-12			34.7	5.15
CLADRANG-1	555239	1700	2100	890	1100	720	570	370	79	
CLADRANG-2	255240	690	1700	330	740	610	290	370	31	
CLADRANG-3	555241	970	2100	430	950	660	380	400	40	70.79
CLADRANG-4	555242	1200	1500	620	940	580	470	360	- 52	
CLADRANG-5	555243	1100	2100	490	1000	730	410	450	-45	- 1
CLADRANG-7	555244	650	1400	290	85ó	550	280	370	28	
CLADRANG-8	555245	1000	1300	470	810	460	400	280	40	4-1-1
CLADRANG-9	555246	1400	1800	660	870	620	540	1310	.,60	
CLADRANG-10	555247	1000	1400	430	. 870	500	410	340	35	
CLADRANG-11	555248	850	1200	440	580	440	360	270	34	
	1.1			L3: 11:	2-7-774				A 15. 12	
CLADSTEL-1	555249	650	1400	90	890	490	260	360	. 29	
CLADSTEL-2	555250	. · 580	7,1500	280	1000	550	280 T	500	24	
CLADSTEL-3	555251	650	1300 .	300	960 2.	480	280	380 /	29	11.10
CLADSTEL-4	555252	630	1200	280	770	420	270	360	27	one ion Ballet.
CLADSTEL-5	555253	530	1400	240	920	520	230	370	24	Carrie
CLADSTEL-7	555254	1200 +	980	530	1000	430	400	340	50	
CLADSTEL-8	555255	390 =	960	180	870	370	200	390	. 17	L'
CLADSTEL-9	555256	400	1000	200	930	420	200	370	18	-14
CLADSTEL-10	555257	1000	1500	430	900	500	380	380	40	40.00
CLADSTEL-11	555258	530	1400	270	940	460	250	430	. 25	
			region s	er i eus de de					Topodo A	
CLADUNCL-1	555259	7640 7	12001	350	710	440	280	310	- 32	į
CLADUNCL-2	555260	590	-1500 ·	290 🐣	680	460	z 280	350	27	
CLÀDUNCL-3	555261	550	1500	260	820	520	290	290	724	
CLADUNCL-4	555262	630	M1400	340	710	430	310	340	31	<u> </u>
CLADUNCL-5	555263	, 2 930 A	1800	430	= 896 - **	590	370	340	38	手头
CLADURCL-7	555264		1200 °	370	676	390	320	300	33	1
CLADUNCL-8	555265	. 1 800 L	1300	2390 €	704	490	330	310	28	-
CLADUNCL-9	555266	640	2800	320	642	660	370	310	29	
CLADUNCL-10	555267	1100	1400	520	935	500	450	380	1442	
CLADUNCL-11	1.279	360	1500	190	585	450	250	290	7.17	

^{*} ppm dry-weight basis

CLADRANG - <u>Cladina rangiferina</u> CLADSTEL - <u>Cladina stellaria</u> CLADUNCL - <u>Cladonia unicialis</u>

Appendix C. Elemental concentrations in lichen samples from Chisik Island, June 1993.*

CLADRANG-1 0.10 0.10 0.02 <0.05 2.47 CLADRANG-2 0.10 0.10 0.03 <0.05 1.33 CLADRANG-3	Sample ID	As, ppm	Se, ppm	Hg, ppm	Tota. S, *	Ash, t
CLADRANG-2 0.10 0.10 0.03 <0.05 1.33 CLADRANG-3 10 0.10 0.02 <0.05 1.73 CLADRANG-4 0.10 0.20 0.03 <0.05 1.87 CLADRANG-5 0.10 0.10 0.02 0.05 1.87 CLADRANG-7 0.10 0.20 0.02 <0.05 1.87 CLADRANG-8 0.10 0.20 0.02 <0.05 1.20 CLADRANG-9 0.10 0.10 0.02 <0.05 1.47 CLADRANG-10 0.10 0.10 0.02 <0.05 1.53 CLADRANG-11 0.10 0.10 0.02 <0.05 1.53 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADRANG-11 0.10 0.30 0.02 0.05 1.27 CLADSTEL-1 0.02 0.05 1.27 CLADSTEL-2 0.10 0.30 0.02 0.05 1.20 CLADSTEL-3 6.10 0.30 0.02 0.05 1.20 CLADSTEL-4 0.10 0.30 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-7 0.10 0.40 0.03 0.06 1.60 CLADSTEL-8 <0.05 0.30 0.02 0.05 0.67 CLADSTEL-9 <0.05 0.40 0.02 0.05 0.93 CLADSTEL-10 0.10 0.30 0.03 0.05 0.53 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-10 0.10 0.30 0.05 0.05 1.13 CLADSTEL-10 0.10 0.30 0.05 0.05 1.13 CLADSTEL-10 0.10 0.30 0.05 0.05 1.13 CLADSTEL-10 0.10 0.30 0.05 0.06 1.13 CLADSTEL-10 0.10 0.30 0.05 0.06 1.13 CLADSTEL-10 0.10 0.10 0.04 <0.05 1.13 CLADURCL-1 0.10 0.10 0.04 <0.05 1.13 CLADURCL-2 0.10 0.10 0.04 <0.05 1.13 CLADURCL-3 0.10 0.10 0.04 <0.05 1.13 CLADURCL-5 0.10 0.10 0.04 <0.05 1.20 CLADURCL-7						
CLADRANG-2 0.10 0.10 0.03 <0.05 1.33 CLADRANG-3 T 10 0.10 0.02 <0.05 1.73 CLADRANG-4 0.10 0.20 0.03 <0.05 1.87 CLADRANG-5 0.10 0.10 0.02 0.05 1.87 CLADRANG-7 0.10 0.20 0.02 <0.05 1.20 CLADRANG-8 0.10 0.20 0.03 <0.05 1.47 CLADRANG-9 0.10 0.10 0.02 <0.05 1.53 CLADRANG-10 0.10 0.10 0.02 <0.05 1.53 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADSTEL-1 0.02 0.05 1.27 CLADSTEL-2 0.10 0.30 0.02 0.05 1.27 CLADSTEL-3 0.10 0.30 0.02 0.05 1.20 CLADSTEL-4 0.10 0.30 0.02 0.05 1.30 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-7 0.10 0.30 0.02 0.05 1.13 CLADSTEL-8 <0.05 0.30 0.02 0.05 1.13 CLADSTEL-9 <0.05 0.30 0.02 0.05 1.13 CLADSTEL-1 0.10 0.30 0.02 0.05 0.87 CLADSTEL-1 0.10 0.30 0.02 0.05 0.87 CLADSTEL-1 0.10 0.30 0.03 0.05 1.53 CLADSTEL-1 0.10 0.30 0.05 0.05 1.13 CLADSTEL-1 0.10 0.10 0.04 0.05 1.13 CLADSTEL-1 0.10 0.10 0.04 0.05 1.13 CLADSTEL-1 0.10 0.10 0.04 0.05 1.13 CLADURCL-1 0.10 0.10 0.04 0.05 1.13 CLADURCL-2 0.10 0.10 0.04 0.05 1.13 CLADURCL-3 0.10 0.10 0.04 0.05 1.20 CLADURCL-5 0.10 0.10 0.04 0.05 1.23 CLADURCL-6 0.10 0.10 0.04 0.05 1.23 CLADURCL-7	CLADRANG-1	0.10	0.10	0.02	<0.05	2.47
CLADRANG-3			2040.10	0.03	<0.05	1.33
CLADRANG-4 0.10 0.20 0.03 <0.05 1.87 CLADRANG-5 0.10 0.10 0.02 0.05 1.87 CLADRANG-7 0.10 0.20 0.02 <0.05 1.20 CLADRANG-8 0.10 0.20 0.03 <0.05 1.47 CLADRANG-9 0.10 0.10 0.02 <0.05 2.07 CLADRANG-10 0.10 0.10 0.02 <0.05 1.53 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADRANG-11 0.10 0.30 0.02 0.05 1.27 CLADSTEL-1 0.02 0.05 1.27 CLADSTEL-3 C.10 0.30 0.02 0.05 1.27 CLADSTEL-3 C.10 0.30 0.02 0.05 1.20 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-7 0.10 0.40 0.02 0.05 1.13 CLADSTEL-8 0.05 0.30 0.02 0.05 0.87 CLADSTEL-9 <0.05 0.40 0.02 0.05 0.93 CLADSTEL-10 0.10 0.30 0.02 0.05 0.93 CLADSTEL-10 0.10 0.30 0.02 0.05 1.53 CLADSTEL-11 0.05 70.30 0.03 0.05 1.53 CLADSTEL-10 0.10 0.30 0.02 0.05 1.13 CLADSTEL-10 0.10 0.30 0.02 0.05 1.13 CLADSTEL-10 0.10 0.30 0.02 0.05 1.13 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-10 0.10 0.30 0.05 0.05 1.13 CLADSTEL-10 0.10 0.04 0.02 0.05 1.13 CLADSTEL-10 0.10 0.04 0.02 0.05 1.13 CLADSTEL-11 0.05 70.30 0.05 0.05 1.13 CLADSTEL-10 0.10 0.10 0.04 0.05 1.13 CLADURCL-2 0.10 0.10 0.04 0.05 1.13 CLADURCL-3 0.10 0.10 0.04 0.05 1.20 CLADURCL-4 0.10 0.10 0.04 0.05 1.20 CLADURCL-5 0.10 0.10 0.04 0.05 1.23 CLADURCL-6 0.10 0.10 0.04 0.05 1.23 CLADURCL-7 0.00 0.10 0.04 0.05 1.23 CLADURCL-8 0.10 0.10 0.04 0.05 1.51 CLADURCL-9 0.10 0.10 0.04 0.05 1.51 CLADURCL-10 0.10 0.10 0.04 0.05 1.51		C 10	0.10	0.02	<0.05	1.73
CLADRANG-7 0.10 0.20 0.02 <0.05 1.20 CLADRANG-8 0.10 0.20 0.03 <0.05 1.47 CLADRANG-9 0.10 0.10 0.02 <0.05 2.07 CLADRANG-10 0.10 0.10 0.02 <0.05 1.53 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADSTEL-1	1	0.10	0.20	0.03	. <0.05	1.87
CLADRANG-7 0.10 0.20 0.02 <0.05 1.20 CLADRANG-8 0.10 0.20 0.03 <0.05 1.47 CLADRANG-9 0.10 0.10 0.02 <0.05 2.07 CLADRANG-10 0.10 0.10 0.02 <0.05 1.53 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADSTEL-1 0.02 0.05 1.27 CLADSTEL-2 0.10 0.30 0.02 0.05 1.27 CLADSTEL-3 C.10 0.30 0.02 0.05 1.20 CLADSTEL-4 0.10 0.30 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-7 0.10 0.40 0.03 0.06 1.60 CLADSTEL-8 <0.05 0.30 0.02 0.05 0.87 CLADSTEL-9 <0.05 0.30 0.02 0.05 0.87 CLADSTEL-10 0.10 0.40 0.03 0.05 0.87 CLADSTEL-11 0.10 0.30 0.02 0.05 0.93 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 70.30 0.03 0.05 1.53 CLADSTEL-10 0.10 0.30 0.05 0.06 1.13 CLADURCL-1 0.10 0.10 0.05 0.05 0.06 1.13 CLADURCL-2 0.10 0.10 0.04 <0.05 1.13 CLADURCL-3 0.04 <0.05 1.13 CLADURCL-4 0.10 0.10 0.04 <0.05 1.13 CLADURCL-5 0.10 0.10 0.04 <0.05 1.33 CLADURCL-5 0.10 0.10 0.04 <0.05 1.33 CLADURCL-7 0.04 <0.05 1.33 CLADURCL-7 0.04 <0.05 1.33 CLADURCL-8 0.10 0.10 0.04 <0.05 1.33 CLADURCL-8 0.10 0.10 0.04 <0.05 1.33 CLADURCL-8 0.10 0.10 0.04 <0.05 1.33 CLADURCL-9 C.10 0.10 0.04 <0.05 1.53 CLADURCL-9 C.10 0.10 0.04 <0.05 1.53 CLADURCL-9 C.10 0.10 0.04 <0.05 1.53		0.10	0.10	0.02	0.05	1.87
CLADRANG-8 0.10 0.20 0.03 <0.05 1.47 CLADRANG-9 0.10 0.10 0.02 <0.05 2.07 CLADRANG-10 0.10 0.10 0.02 <0.05 1.53 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADSTEL-1 0.02 0.05 1.27 CLADSTEL-2 0.10 0.30 0.02 0.05 1.27 CLADSTEL-3 0.10 0.30 0.02 0.05 1.20 CLADSTEL-4 0.10 0.30 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-7 0.10 0.40 0.03 0.06 1.60 CLADSTEL-8 <0.05 0.30 0.02 0.05 0.87 CLADSTEL-9 0.05 0.40 0.02 0.05 0.93 CLADSTEL-10 0.10 0.30 0.03 0.05 0.93 CLADSTEL-11 0.05 70.30 0.03 0.05 1.53 CLADSTEL-11 0.05 70.30 0.05 0.06 1.13 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-10 0.10 0.30 0.05 0.06 1.13 CLADURCL-1 0.05 70.30 0.05 0.06 1.13 CLADURCL-2 0.10 0.10 0.04 <0.05 1.13 CLADURCL-3 0.10 0.10 0.04 <0.05 1.20 CLADURCL-5 0.10 0.10 0.04 <0.05 1.23 CLADURCL-6 0.10 0.10 0.04 <0.05 1.23 CLADURCL-7 0.04 <0.05 1.23 CLADURCL-8 0.10 0.10 0.04 <0.05 1.33 CLADURCL-8 0.10 0.10 0.04 <0.05 1.33 CLADURCL-9 0.10 0.10 0.04 <0.05 1.53		0.10	0.20	0.02	<0.05	1.20
CLADRANG-9 0.10 0.10 0.02 <0.05 2.07 CLADRANG-10 0.10 0.10 0.02 <0.05 1.53 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADSTEL-1 0.02 0.05 1.20 CLADSTEL-2 0.10 0.30 0.02 0.05 1.27 CLADSTEL-3 C.10 0.30 0.02 0.05 1.20 CLADSTEL-4 0.10 0.20 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-7 0.10 0.40 0.03 0.06 1.60 CLADSTEL-8 <0.05 0.30 0.02 0.05 0.87 CLADSTEL-9 <0.05 0.40 0.02 0.05 0.87 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 0.30 0.05 1.53 CLADSTEL-11 0.05 0.30 0.05 1.13 CLADSTEL-11 0.05 0.30 0.05 1.13 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 0.30 0.05 1.13 CLADSTEL-11 0.05 0.30 0.05 1.13 CLADSTEL-11 0.05 0.30 0.05 1.13 CLADSTEL-10 0.10 0.10 0.04 <0.05 1.13 CLADURCL-2 0.10 0.10 0.04 <0.05 1.13 CLADURCL-3 0.04 <0.05 1.20 CLADURCL-5 0.10 0.10 0.04 <0.05 1.23 CLADURCL-5 0.10 0.10 0.04 <0.05 1.23 CLADURCL-6 0.10 0.10 0.04 <0.05 1.23 CLADURCL-7 0.04 <0.05 1.23 CLADURCL-8 0.10 0.10 0.04 <0.05 1.33 CLADURCL-8 0.10 0.10 0.04 <0.05 1.33 CLADURCL-9 0.10 0.10 0.04 <0.05 1.33 CLADURCL-9 0.10 0.10 0.04 <0.05 1.33 CLADURCL-9 0.10 0.10 0.04 <0.05 1.53 CLADURCL-9 0.10 0.10 0.04 <0.05 1.53 CLADURCL-10 0.10 0.10 0.04 <0.05 1.53			0.20	0.03	<0.05	1.47
CLADRANG-10 0.10 0.10 0.02 <0.05 1.53 CLADRANG-11 0.10 0.10 0.02 <0.05 1.27 CLADSTEL-1 0.02 0.05 1.20 CLADSTEL-2 0.10 0.30 0.02 0.05 1.27 CLADSTEL-3 6.10 0.30 0.02 0.05 1.20 CLADSTEL-4 0.10 0.20 0.02 0.05 1.30 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-7 0.10 0.40 0.03 0.06 1.60 CLADSTEL-8 <0.05 0.30 0.02 0.05 0.87 CLADSTEL-9 <0.05 0.40 0.02 0.05 0.87 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 0.30 0.03 0.05 1.53 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 0.30 0.05 0.06 1.13 CLADSTEL-11 0.05 0.30 0.05 0.06 1.13 CLADSTEL-1 0.10 0.10 0.30 0.05 1.20 CLADSTEL-1 0.00 0.10 0.04 <0.05 1.13 CLADURCL-1 0.10 0.10 0.04 <0.05 1.20 CLADURCL-2 0.10 0.10 0.04 <0.05 1.20 CLADURCL-3 0.04 <0.05 1.23 CLADURCL-5 0.10 0.10 0.04 <0.05 1.23 CLADURCL-5 0.10 0.10 0.04 <0.05 1.23 CLADURCL-6 0.10 0.10 0.04 <0.05 1.23 CLADURCL-7 0.04 <0.05 1.23 CLADURCL-8 0.10 0.10 0.04 <0.05 1.33 CLADURCL-9 0.10 0.10 0.04 <0.05 1.53		0.10	0.10	0.02	<0.05	2.07
CLADSTEL-1 0.02 0.05 1.20 CLADSTEL-2 0.10 0.30 0.02 0.05 1.27 CLADSTEL-3 C.10 0.30 0.02 0.05 1.20 CLADSTEL-4 0.10 0.30 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-7 0.10 0.40 0.03 0.06 1.60 CLADSTEL-8 <0.05 0.30 0.02 0.05 0.87 CLADSTEL-9 <0.05 0.40 0.02 0.05 0.87 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 70.30 0.03 0.05 1.53 CLADSTEL-11 0.05 70.30 0.05 0.06 1.13 CLADURCL-1 0.10 0.10 0.30 0.05 1.13 CLADURCL-2 0.10 0.10 0.05 0.06 1.13 CLADURCL-3 0.10 0.10 0.04 0.05 1.20 CLADURCL-4 0.10 0.10 0.04 0.05 1.3 CLADURCL-5 0.10 0.10 0.04 0.05 1.3 CLADURCL-7 0.04 0.05 1.23 CLADURCL-7 0.04 0.05 1.23 CLADURCL-8 0.10 0.10 0.04 0.05 1.23 CLADURCL-9 1.0 0.10 0.04 0.05 1.33 CLADURCL-10 0.10 0.10 0.04 0.05 1.33		0.10	0.10	0.02	<0.05	1.53
CLADSTEL-2 0.10 0.30 0.02 0.05 1.27 CLADSTEL-3 6.10 0.30 0.02 0.05 1.20 CLADSTEL-4 0.10 0.30 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-7 0.10 0.40 0.03 0.06 1.60 CLADSTEL-8 90.05 0.30 0.02 0.05 0.87 CLADSTEL-9 0.05 0.40 0.02 0.05 0.87 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 0.30 0.05 1.13 CLADURCL-1 0.10 0.10 0.05 0.05 1.13 CLADURCL-2 0.10 0.10 0.04 0.05 1.13 CLADURCL-3 0.04 0.05 1.20 CLADURCL-4 0.10 0.10 0.04 0.05 1.20 CLADURCL-5 0.10 0.10 0.04 0.05 1.20 CLADURCL-5 0.10 0.10 0.04 0.05 1.23 CLADURCL-6 0.10 0.10 0.04 0.05 1.23 CLADURCL-7 0.04 0.05 1.23 CLADURCL-7 0.04 0.05 1.23 CLADURCL-8 0.10 0.10 0.04 0.05 1.23 CLADURCL-6 0.10 0.10 0.04 0.05 1.33 CLADURCL-7 0.04 0.05 1.33 CLADURCL-6 0.10 0.10 0.04 0.05 1.33 CLADURCL-7 0.04 0.05 1.33 CLADURCL-6 0.10 0.10 0.04 0.05 1.53 CLADURCL-7 0.04 0.05 1.53 CLADURCL-10 0.10 0.10 0.04 0.05 1.53		0.10	0.10	0.02	<0.05	1.27
CLADSTEL-2 0.10 0.30 0.02 0.05 1.27 CLADSTEL-3 6.10 0.30 0.02 0.05 1.20 CLADSTEL-4 0.10 0.30 0.02 0.05 1.13 CLADSTEL-5 0.10 0.30 0.02 0.05 1.13 CLADSTEL-7 0.10 0.40 0.03 0.06 1.60 CLADSTEL-8 90.05 0.30 0.02 0.05 0.87 CLADSTEL-9 0.05 0.40 0.02 0.05 0.87 CLADSTEL-10 0.10 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 0.30 0.03 0.05 1.53 CLADSTEL-11 0.05 0.30 0.05 1.13 CLADURCL-1 0.10 0.10 0.05 0.05 1.13 CLADURCL-2 0.10 0.10 0.04 0.05 1.13 CLADURCL-3 0.04 0.05 1.20 CLADURCL-4 0.10 0.10 0.04 0.05 1.20 CLADURCL-5 0.10 0.10 0.04 0.05 1.20 CLADURCL-5 0.10 0.10 0.04 0.05 1.23 CLADURCL-6 0.10 0.10 0.04 0.05 1.23 CLADURCL-7 0.04 0.05 1.23 CLADURCL-7 0.04 0.05 1.23 CLADURCL-8 0.10 0.10 0.04 0.05 1.23 CLADURCL-6 0.10 0.10 0.04 0.05 1.33 CLADURCL-7 0.04 0.05 1.33 CLADURCL-6 0.10 0.10 0.04 0.05 1.33 CLADURCL-7 0.04 0.05 1.33 CLADURCL-6 0.10 0.10 0.04 0.05 1.53 CLADURCL-7 0.04 0.05 1.53 CLADURCL-10 0.10 0.10 0.04 0.05 1.53					0.05	1 20
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CLADUNCL-7	CLADUNCL-4	11000	12	0.04	1.72	
CLADURCL-8 0.10 0.10 0.04 <0.05 1.33 CLADURCL-9 0.10 0.10 0.14 <0.05 1.53 CLADURCL-10 0.10 0.10 0.03 <0.05 1.67	CLADURCL-5	0.10	0.10	ISBN 1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-		[25] 전 10 (6) : 1 (6) 이 경기를 받는 것 같습니다.
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CLADUNCL-10 0.10 0.10 0.03 <0.05 1.67	CLADUNCL-8	0.10	0.10	0.04		
	CLADUNCL-9		0.10	0.14	- <0.05	
CLADONCL-11 <0.05 0.10 0.06 <0.05 0.93	CLADUNCL-10	0.10	0.10	0.03	<0.05	장미 개발이 하는 이 사는 경기를 하는데 다.
	CLADUNCL-11	<0.05	0.10	7×0.04	<0.05	0.93
				41.		

^{*} ashed basis data

CLADRANG - Cladina rangiferina CLADSTEL - Cladina stellaria CLADUNCL - Cladonia unicialis

Appendix C. Elemental concentrations in lichen samples from Chisik Island, June 1993.*

	21:12.2:		Sout .	10		:			1.00		4	74.5-			- 1	100	· · · · · · · · · · · · · · · · · · ·	20
Sample ID	Mo. p	pm - Mb.	ppm 1	Nd, 1	ppm	Ni,	ppm	Pb.	ppm	Sc,	ppm	Sr.	ppm.	V, ppm	Y	. ppm	Zn, ppm	
				ÅG, 15,1.		1 (7)			1.7						4-4			
CLADRANG-1		8		9	-4	- 18	11.	-27	-	12		- 620		120	(3)	15 -	520	4
CLADRANG-2	<4	<8		_8_		140		_40		9		860		77		12	1800	
CLADRANG-3	* ' . S	<8	10 / 11 PK	10		20		29		8		830		77		12	930	
CLADRANG-4	1-1-4	<8		10		24		36		11	7	630		100		L4	600	
CLADRANG-5	4	<8	400	<8		20		29	gran.	. 9	300	760	0.0	78 .		12	- 88C	
CLADRANG-7	4	<8		8		32		48	11111	9	10000	870		72	1 2 7 7 7 7	L2	1100	
CLADRANG-8	5	<8		11		35		70	974	7.11	77 300	780		96		.6	800	
CLADRING-1	44 L	8	7	9	1 1 1 to	18	77.7	:5	به ماید شد. د	10	of the sale	700		98		3	660	
CLADRANG-10	<4	<8		10	e den	23	5.5	41	100	. 9		750		82 _	,	3	750	
CLADRANG-11	A 6	<8	New York	11		28 .		56	Ý	11	4.	750	- 1	100		7.	550	
		113		1	- 7	7-7	19.5		T.F.		I and a st					1.18		7
CLADSTEL-1	1	<8	700	12	7 147	.71	77.7	45	0.37	. 9	7145	810	á,	79	2 14 TH 3	8	1100	
CLADSTEL-2	4	<8		<8	7	68		47	Y-11.	.8	-	830	- 10- 10-	72		3	1100	
CLADSTEL-3		<8		12		49		88		. 9.	11333	800		81 '		4	1200	1
CLADSTEL-4	4.	<8		16		64	A. 140	59	2Te	9	arras	830		- 80 -		8	- 990	
CLADSTEL-5	and the same of	<8	Andrews	11		25	and of	42	to the	8	and the same	850	62,141	69	1	3	1300	4
CLADSTEL-7	V <4	8	production of the second	12		24	1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	36	- 17	11	This.	560	. 4.	100	1	8	690	-
CLADSTEL-8	-44	- ×8		10 _	3.0	27	2	77	1 2	8		.810		66	1	3	1200	
CLADSTEL-9	 5 i	1. Spot <8		12		34	4	77	. 7	w 8	144	200		68	12.1	5	1000	
CLADSTEL-10	44	<8	700	20	1	26	100	84		-10	4-1	820	-50	83	1	9 -	920	
CLADSTEL-11		28		10		25	z.,	48		. 2		850	2.3	76	1	4	1200	
		10.1		4.		21.2		25.7					1					
CLADUSCL-1	24	8		11		48	****	91	-1	10		850	1	97	1	5	1000	
CLADUSCL-2	<0	8>+		11	P.	28	7.	61	4	. 9	Your	900		-77		3	1100°	1
CLADORCL-3	$\pi'(\Omega)$	8> T		8	70	36		55	*	7.		940	100	67	1	1	1600	
CLADUSCL-4	द(क	<8	4	12 -		28		44	I	210	1	880	3.5	2 91 ·	4.11	6 olected	950	-
CLADUSCL-5	1 The	<8		9	3	30		53		<u>.</u> 9		820	-	83	: 1	3	1300	
CLADUNCL-7	<0	48 ×8	2	11 7		32	*	82		10	-	790	41	89	1	5	980	-
CLADUSCL-8	20	48		14		62	72.	62	1	9		850	e 1 - 52	90	1	6	1300	
CLADUSCL-9	10	<8	1	48		38	227	52		7.		1300		61	1	0	1200	1
CLADUNCL-10	20 e4	<8		11		99	TA . 2. "**	54	The Replace of	10	2	710		95.	1	5	1100	100
CLADOSCL-11	13	777. <8	1	9	10	83		110	5-12-	7 6	214.87	1200	1	61	- 1	3	940	3
all for the form of the second	74						_	_	-	-	-	-						

* ashed basis data

CLADRANG - Cladina rangiferina
CLADSTEL - Cladina stellaria
CLADUNCL - Cladonia unicialis

Elemental concentrations in lichen samples from Chisik Island, June 1993.*

	Sample ID	Mn, ppm	Ba, ppm	Cd. ppm	Ce, ppm	Co, ppm	Cr. ppm	Çu ppm	Ga, ppm	La, ppm	Li,ppm
i						i la		130	15	14	18
-	CLADRANG-1	2000	530	<4	21	15	27	230	12	13	16
	CLADRANG-2	5400	550	<4	19	12 .	31		12	13	15
	CLADRANG-3	2600	540	<4	17	11	22	190	14	14	17
	CLADRANG-4	2200	610	<4	20	14	29 χ	130	15	=12	15
1	CLADRANG-5	2800	580	<4	19	11	22	180	13	13	15
	CLADRANG-7	2600	660	<4	18	12	29	230	15	16	18
	CLADRANG-8	1100	660	<4	25	13	35	170	14	13	16
2.	CLADRANG-9	2100	700	· · · · · · ·	20	13	25	140	14	13	16
	CLADRANG-10	1800	, 680	<4	20	13	26	160	16	15	. 17
-	CLADRANG-11	2300	710	<4	26	15	40	160			
1		Education .							'13	16	14
	CLADSTEL-1	3700	480	<4	47	. 14	28	200	11	12	15
	CLADSTEL-2	3700	490	<4	20	12	29	220	12		15
	CLADSTEL-3	2600	21.540	<6	20	12	27	210	12	16	- 15
	CLADSTEL-4	2200	570	e e e e e e e e e e e e e e e e e e e	28	13	28	330	11	12	14
N.	CLADSTEL-5	-4400	510	<4	20	. 11	27	260	And the second	16	17
	CLADSTEL-7	1700 ·	630	<4	25	13	26 25	The second secon	10	12	13
10	CLADSTEL-8	2400	580	/ 44	20	11		270	为是"在下午"的大概的	15	13
17	CLADSTEL-9	1800	540	1,21,50,0	26	11 7/2	28	330 =	14	17	16
7	CLADSTEL-10	1400	630	- 44	30	13	28	210	74. A.	13	14
	CLADSTEL-11	2500	590	/	- 22	11	/ 35	280		Maranin is	
	11.1							180	12	15	16
	CLADUSCL-1	2700	<u></u>	-44	1.25	.14	32	620	10 "	13	16
	CLADORCL-2	23300	590	44	18	12	7.29	TATE OF STREET			4 15
	CLADUNCL-3	2400	490	<4	. 16	-u	27	340	12 7	114	16
	CLADUMCL-4	3000	580	. 4	22	. 12	29		lu .	G 13	16
	CLADURCL-5	2600	500	<4	18	12	30 17 1	180	15	715	- 16
	CLADURCL-7	2000	620	<4	26	12	29	230	14	This 1	16
	CLADONCL-8	1600	630	<4	25	13	30 1	190			14
	CLADORCI -9	1200	620	<4	16	. 10	23	260	14	14	17
* .	CLADUSCL-10	₹ 1900	650	<4	26	- 14	31	180 930 ×			16
	CLADUNCI-11	2900	620	<4	21	11	28	6 T. W. D. W. S. C. L.	****	medical residence	
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major.	A Total Street of the latest of the latest owner and displaced and the	A				The second secon	the first of the second of the second of the second	Cartinate and the second of th	A PLANT OF THE PARTY OF THE PAR	Charles T. M. Philadelphia and the	Section of the second section of the second

^{*} ashed basis data

CLADRANG - Cladina rangiferina CLADSTEL - Cladina stellaria CLADUNCL - Cladonia unicialis

Appendix C. Elemental concentrations in lichen samples from Chisik Island, June 1993.*

	17 - 19 45			Televician	47-41		7 July 20	P. 1	Ti. %	enege: 3500° 34
Sample ID	Lab #	Al, &	Ca, *	Fe. t	K. *	Mg.	t Na. t			
Sample ID							0.41340 0000			
	555239	7.0	8.5	3.6	4.3	2.9	2.3	1.5	0.32	
CLADRANG-1	555240	5.2	13	2.5	5.6	4.6	3-2.2	2.8	0.23	in Early State
CLADRANG-2		5.6	-12	2.5	- 5.5	3.8	2,2	2.3	0.23	
CLADRANG-3	- 55 241	6.6	7.9	3.3	5.0	3.1	2.5	1.9	0.28	Selfahar Selfah
CLADRANG-4	555242	A	11	2.6	5.6	3.9	2.2	2.4	0.24	*
CLADRANG-5	555243	5.8		2.4	7.1	4.6	¥7.2.3	3.1	23	
CL*CPAMG-7	555244	5.4	. 12	3.2	5.5	3.1	62.7	1.9	U.27	
CLADRANG-8	555245	6.8	8.8		4.2	3.0	2.6	1.5	0.29	
CLADRANG-9	555246	7.0	8.7	3.2	5.7	3.3	2.7	2.2	0.23	
CLADRANG-10	555247	6.7	9.0	2.8			2.8	2.1	0.27	
CLADRANG-11	555248	6.7	9.4	3.5	4.6	3.5	zák y cza			
N. 4. 52 Li 57 U. 147		A			(1) 12 to 1		2.2	3.0	0.24	meny factor of
CLADSTEL-1	555249	5.4	12	2.4	7.4	. 4.1	1507	3.9	0.19	Annual Control
CLADSTEL-2	555250	4.6	12	2.2	7.9	4.3	2.2	and the till and a	0.24	
CLADSTEL-3	555251	5.4	11	2.5	8.0	4.0	of the State of the Land	501 3.2	0.24	A Section of the sect
CLADSTEL-4	355252	5.6	11	2.5	6.8	3.7	2.4	3.2	The same of the same of the	
distribution of the	555253	4.7	12	2.1	1 B.1	4.6	2.0	2.3	- 0.21	
CLADSTEL-5	555254	7.2	6.1	3.3	6.4	, 2.7	2.5	2.1	0.31	grant and the second of the se
CLADSTEL-7	The second second	4.5	11	2.1	10	State of the last	2.3	4.5	0.20	Light Children
CLADSTEL-8	\$55255	4.3	11	2.1	10	4.5		4.0	6.19	
CLADSTEL-9	555256		9.5	2.8	5.9	3.3	2.5	2.5	0.26	
CLADSTEL-10	,555257	6.7		2.4	8.3	4.1	**72.2		0.22	Description of the second
CLADSTEL-11	555258	4.7	12	age of the specific of the second	77.1			Project Comment	200	
			The Branch		6.3	3.3	2.5	2.7	- 0.28 ×	
CLADUNCI-1	555259	5.7	11	3.1	6.0	4.1	2.5	3.1	0.24	to the same
CLADUSCL-2	555260	5.2	13	2.6	6.8	4.3	2.4	7.12.4	0.20	For Carpet Con Control
CLADURCL-3	\$55261	4.6	13	and a transfer	6.3		THE WAY	2.0	20.27	
CLADUSCL-4	555262	5.6	. 12	3.0	C. 171	2.7	2.3	2.1	0.24	# 95 to 1
CLADUSCL-5	555263	5.8	· 11	2.7	5.6	100		2.4	0.27	
CLADUSCL-7	555264	6.5	9.4	3.0	5.5	3.2	10	A Section 1	0.21	
CLADOSCL-8	555265	6.0	10	2.9	5.3	3.7	1	2.0	0.19	
CLADUSCL-9	555266	4.2	1.8	2.1	4.2	4.3	A STATE OF THE STA	A Property of	0.25	Employee By Transport on the Section of the Control
CLADUNCI-10	555267	6.6	8.5	3.1	5.6	3.0	The state of the s	2.3	Traction or had	
CIADURCL-11	35 553268		16	2.0	6.3	4.8	2.7	23.1	0.18	TO PARTY IN
	Late of the 12	The second	11-1-11-11			· 6 · 9#	and the series	1		
			LANGE WELL	- C.	SPATE AND ADDRESS.	15 207	7.25	2/-		Cara Cara

^{*} ashed basis data

CLADRANG - Cladina rangiferina CLADSTEL - Cladina stellaria CLADUNCL - Cladonia unicialis

Appendix C. Elemental concentrations in lichen samples from Chisik Island, June 1993.*

Sample ID	As, ppm	Se, ppm	Hg, ppm	Total S, \$	Ash, t	
CLADRANG-1	0.10	0.1	0.02	<0.05	2.47	14. 1
CLADRANG-2	0.10	0.1	0.03	<0.05	1.33	
CLADRANG-3	- 0-10	0.1	0.02	<0.05	1.73	
CLADRANG-4	0.10	0.2	0.03	<0.05	1.87	
CLADRANG-5	0.10	0.1	0.02	0.05	1.87	
CLADRANG-7	0.10	0.2	0.02	_<0.05 +	1.20	
CLADRANG-8	0.10	0.2	0.03	<0.03	1.47	
CLADRANG-9	0.10	0.1	0.02	40.05	2.07	
CLADRANG-10	0.10	0.1	0.02	<0.05	1.53	
CLADRANG-11	0.10	0.1	0.02	<0.05	1.27	
	GENERAL TO THE STATE OF				1	
CLADSTEL-1			0.02	0.05	1.20	2.10.11.20
CLADSTEL-2	0.10	0.3	0.02	0.05	1.27	215.23
CLADSTEL-3	0.10	0.3	0.02	0.05	1.20	Land Control Land
CLADSTEL-4	0.10	0.3	0.02	0.05	1.13	
CLADSTEL-5	0.10	0.3	0.02	0.05	1.13	derination of the same of
CLADSTEL-7	0.10	0.4	0.03	0.06	1.60	And other Property of the American
CLADSTEL-8	<0.05	0.3	0.02	0.05	0.87	
CLADSTEL-9	₹0.05	7 0.4	0.02	0.05	0.93	and the
CLADSTEL-10	0.10	0.3	0.03	0.05	1.53	of frage strain
CLADSTEL-11	0.05	0.3	0.05	0.06	1.13	V 10
A CONTRACT			e Person	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
CLADONCL-1	0.10	0.1	0.05	<0.05	-1.13	THE THE REAL PROPERTY.
CLADORCL-2	23.20.10	0.1	0.04	1-<0.05	1.11	
CLADUNCL-3		7-4	0.06	9 <0.05 y N		
CLADUSCL-4	0.10	0.1	0.04	- co.os	2.13	
CLADURCL-5	0.10	0.1	0.04	<0.05	1.60	
CLADUSCL-7		· · · · · · · · · · · · · · · · · · ·	0.04	. <0.05	1.23	
CLADUSCL-8	0.10	0.1	0.04	70 <0.05	1.33	231.434.63
CLADURCL-9		0.1	0.04	<0.05	41.53	
CLADOSCL-10	0.10	0.1	0.03	<0.05	1.67	ZJ.
CLADUSCL-11	<0.05	0.1	0.04	<0.05	0.93	M Zh
The state of the	See Line		to a season	The second second	The state of the s	

^{*} ppm dry-weight basis

CLADRANG - Cladina rangiferina CLADSTEL - Cladina stellaria CLADUNCL - Cladonia unicialis

Appendix C. Elemental concentrations in lichen samples from Chisik Island. June 1993.*

		/									1.1.1.	4.5
	Sample ID	Mo, ppm	Mb, ppm	Md, ppm	Mt . ppn	Pb. ppm	Sc, ppm	S., ppm	V, ppm	Y, ppm	Zn. ppm	
		والقراف فالمطاعقة	nikarini kari-te			4 1 4 4					. 13	
1	CLADRANG-1	₹0.1	0.2	0.2	0.4	0.67	0.3	15	3.0	6.2	24	
	CLADRANG-2	<0.1	<0.1	0.1	1.9	0.53	0.1	11	1.0	0.2	16	
	CLADRANG-3	0.09	<0.1	0.2	0.4	0.50	0.1	. 14	1.3		11	
	CLADRANG-4	<0.1		0.2		0.67	0.2	12	1.9		Transfer of	
	CLADRANG-5	2 0.07	<0.2	<0.2	0.4	- 0.54	0.2	14	1.5	0.2	- 16	•
1	CLADRANG-7	0.05	<0.1	0.1	0.4	J. 0.58	0.1	10	0.9	0.1	13	
	CLADRANG-8	3 0.07	<0.1	0.2	0.5	1.0	0.2	11	1.4	0.2	12	
	CLADRANG-9	<0.1	0.2	0.2	0.4	0.52	9 0.2 CK	- 14	2.0	0.3	. 13	100
	CLADRANG-10	<0.1	<0.1	0.2	0.4	0.63	0.1	- 11	1.3	0.2	- 11	
	CLADRANG-11	0.08	<0.1	0.1	0.4	0.71	0.1	10	1.3	0.72	7	-
	Province According						And the second	T				.1
1	CLADSTEL-1	- 0.05	<0.1	0.1	0.3	0.54	0.1	10	1.0	0.2	. 13	
	CLADSTEL-2	Z.0.05	<0.1	<0.1	0.9	0.60	0.1	- 11	0.9	0.2	14	10.
*	CLADSTEL-3	0.05	<0.1	0.1	0.6	1.1	0.1	10	1.0	0.2	14	1
	CLADSTEL-4	0.05	" <0.1	0.2		0.67		9	0.9	0.2	111	
-	CLADSTEL-5	and the state of the same	<0.1	0.1	0.3	0.47	0.1	10	\ 0.8	0.2	-15	2 -1
Trans.	CLADSTEL-7	<0.1	0.1	0.2	0.4	₹ 0.58	0.2	9	1.6	0.3	. 11	1
	CLADSTEL-8	*	<0.1	0.1	0.2	0.67	0.1	E. C. 7	0.	0.1	10	٠.
1	CLADSTEL-9	0.05	<0.1	0.1	1 0.1-6	0.72	0.1	. 8	0.6	0.1	9	
+	CLADSTEL-10	Z<0.1	<0.1	0.3	. 0.4	£1.3	.0.2	13	1.3	0.3	14	- '
本は	CLADSTEL-11	20.06	<0.1	0.1	0.3	0.54	0.1	1. 10	0.9	0.2	14	Ξ.
	v stilligksafnings	1.7	P.5.		12-4	War and				34 2 4	14.7 - 18.6s.	
1	CLADUNCL-1	101	Jan 0.1	0.1	0.5	1.0	9.1	10	1.1	0.2	11	1
	W		22 <0.1	0.1	0.3	0.69	1 0.1 1	1.10	0.9	0.2	112	
	CLADUNCL-3	Carlon Many Control of the	**.<0.1	0.1	0.4	0.66	0,1	11	.0.8	0.1	19	
	CLADUNCL-4			0.1	0.31	7.20.50	0.1	110	1.0	0.2	211	17.
1	CLADUNCL-5	<0.1	₹0.1	0.1	0.8	0.85	0.1	65 13 ·	1.3	0.2	21	
7	A Production of the Control of the C	F-0.1	<0.1	0.1	0.4	1.0	0.1	10	1.1	0.2	= 12	5.
	CLADUNCL-7		<0.1	0.2	0.8	0.82	0.1	3711	1.2	. o.2	17	
1	CLADONCL-8	0.15	<0.1	<0.1	10.6	y . 0.80	0.1	220	Q.9	-0.2	18	
1	CLADUNCL-9	MARKET CONTINUES A	€0.1	0.2	1.7 T.	5 0.90	0.2	12 :	1.6	0.3	18	
G	CLADUNCL-10	· · · · · · · · · · · · · · · · · · ·	<0.1	0.1	0.8	1.0	0.1	11	0.6	0.1	F. 6.34	
	CLADUNCL-11	SHE WILLIAM	Sittle of the -	er tra same			and work	entry of	AT NOTE	12 16	A STATE OF	2.
	THE RESIDENCE OF STREET STREET	AND THE PARTY OF T		The second second second	200 1 3 male 200	\$ 40 x 5000 - 00 A	the contract of the same of th				The second second	

^{*} ppm dry-weight basis

CLADRANG - Cladina rangiferina CLADSTEL - Cladina stellaria CLADUNCL - Cladonia uncialis

Appendix C. Elemental concentrations in lichen samples from Chisik Island, June 1993.*

		*	1000			Parameter St.		1.172	10.45			
	Sample ID	Mn, ppm	Ba, ppm	Cd,	ppm	Ca, ppe	Co, ppm	Cr. ppm	Cu. ppm	Ga, ppm	La, ppm	Li. ppm
		49	13	<0.	1.	70.5	0.4	0.67	3.2	0.4	0.4	0.4
i.	CLADRANG-1	72	7	<0.		0.3	0.2	0.41	3.1	, 0.2	0.2	0.2
	CLADRANG-2	45	9	<0.		0.3	0.2	0.38	3.3	70.2	0.2	0.3
	CLADRANG-3		11	<0.		0.4	0.2	0.54	7 2.4	0.3	0.3	0.3
	CLADRANG-4	41		<0.	7. 1	0.4	0.2	0.41	3.4	0.3	0.2	0.3
	CLADRANG-5	52	11	<0.	17.45	0.2	0.1	0.35	2.8	0.2	0.2	0.2
	CLADRANG-7	31		****		0.4	0.2	0.51	2.5	0.2	0.2	0.3
	CLADRANG-8	16	10	<0.	244.75	0.4	0.3	0.52	2.9	0.3	- 0.3	0.3
	CLADRANG-9	43	. 14	<0.			1815 347.1	0.40	2.5	0.2	0.2	0.2
	CLADRANG-10	28	10	<0.1		0.3	0.2	0.51	2.0	0.2	0.2	0.2
	CLADRANG-11	29		<0		0.3	0.2	0.31				
			5.50.41.32	2,345			30.14.0	0.34	2.4	0.2	0.2	0.2
	CLADSTEL-1	. 44	. 6	<0.		0.3	0.2		2.8	0.1	0.2	0.2
	CLADSTEL-2	67		<0.1	2.7	0.3	0.2	0.37	2.5	0.1	0.2	0.2
	CLADSTEL-3	31	المحادث في المحادث الم	<0.1		And the second	0.1	0.32		0.1	0.2	0.2
	CLADSTEL-4	25	6	0.0	05		0.2	0.32		0.1	0.1	0.2
	CLADSTEL-5	50	6	<0.1		A Commission of	-0.1	0.31	2.9		0.3	0.3
**	CLADSTEL-7	27	10	<0.1	-	0.4	0.2	0.42		0.2	0.1	0.1
+	CLADSTEL-8	21	. S	<0.1	L ceta	0.2	0.1	0.22	2.5	0.1		COLUMN TO SERVE
	CLADSTEL-9	17	5.7)5	0.2	0.1	0.26		0.1	0.1	0.1
	CLADSTEL-10	21	10	<0.1	, veri	0.5	0.2	0.43	3.2	A 0.2	0.3	0.2
	CLADSTEL-11	28	7	<0.1		0.3	0.1	0.40	3.2	0.1	0.2	0.2
				720					Z (1.4	T		
	CLADUNCL-1	31	£ 6.	<0.1	1	0.3	0.2	0.36	2:2.0	10.1	0.2	0.2
	CLADUNCL-2	37	7	<0.	. 4	0.2	0.1	0.33	.7.0	0.1	0.2	0.2
-	CLADUNCL-3	29 🛪	6. 0.17	<0.	L Service	0.2	0.1	0.32	7.1	0.1	0.1	0.2
	CLADUSCL-4	34	7	≪0. :	1	0.3	0.1	0.33	3.8	STEFF 0.1	0.2	0.2
	CLADUNCL-5	42		<0.		0.3	0.2	0.48	- 2.9	2.0.2	0.2	., 0.3
1	CLADUNCL-7	25	# # T	<0.	10.14	0.3	0.2	0.36	2.8	0.2	0.2	0.2
4	CLADUNCL-8	21	Contract of the second	-<0.	40.00	Charles Santa	0.2	0.40	2.5	0.2	0.2	0.2
	CLADUNCL-9	17	. 9	<0.		0.2	0.2 .	0.35	4.0	6 0.1	7,0.2	0.2
	,	32	- 11	<0.	11.	0.4	-0.2	0.52	3.0	0.2	0.2	0.3
	CLADUNCL-10	27		<0.		0.2	0.1	0.26	8.7	0.1	0.1	0.2
	CLADUNCL-11		44-1-1-1	2	Market M.	15. 944 EP			14 / 15 B		TN-W1	State of the
					-	-	-		1 TH	AND THE RESERVE OF THE PARTY OF	THE RESERVE	Contractor of the

^{*} ppm dry-weight basis

CLADRANG - Cladina rangiferina CLADSTEL - Cladina stellaria CLADUNCL - Cladonia unicialis

Appendix D

Semipermeable Membrane Devices
Summary Report.

Jim Petty
National Biological Service
Midwest Science Center
Columbia, Missouri

TESTING METHOD/PROTOCOLS REQUIRED FOR THE
CONTAMINANT ASSESSMENT AREA PROCESS - AIR
QUALITY MONITORING TECHNIQUES IN THE
ALASKA MARITIME, NATIONAL WILDLIFE

LEFUGES TUXEDNI WILDERNESS AREA

J.D. Petty

National Biological Survey

Midwest Science Center

4200 New Haven Road

Columbia, MO 65201

INTRODUCTION

an integral part of the National Biological Survey's (NBS)

scological based research program is the need to identify and
evaluate the route; of anthropogenic contaminant transport. The
giomonitoring of Environmental Status and Trends (BEST) Program
is the primary focus within NBS for conducting field studies
is the primary focus within NBS for conducting field studies
transport. The current research effort was undertaken to
determine the potential for airborne contaminant to impact
isolated areas in Alaska.

The semipermeable membrane devices (SPMD) technology has been demonstrated to hold considerable promise for providing time-integrated concentrations of nonionic organic contaminants in aquatic environments, and for estimating the bioavailability and potential bioconcentration of such contaminants, (Huckins, et. al., 1990, 1993). The feasibility of the SPMD approach for monitoring airborne contaminants also appears promising (Petty, et.al., 1993), as the SPMDs mimic the uptake of contaminants via the respiration process.

In an effort to demonstrate the feasibility of the SPMD approach for use in monitoring airborne contaminants, the devices were deployed in the Alaska Maritime National Wildlife Refuges Tuxedni Wilderness area (specifically Chisik Island). The Tuxedni Wilderness is a class I air quality area and is consequently

subject to stringent air quality standards (Clean Air Act, 42 U.S. Code 7401 et seg.). As a positive control, SPMDs were deployed in metropolitan Anchorage. Presented below are the results of the analysis of the SPMDs used in this research effort.

RESULTS AND DISCUSSION

Quality Control:

The SPMDs (N=5) were deployed on Chisik Island and Anchorage
Alaska during June and July, 1993 Following retrieval, the
SPMDs were shipped to the Midwest Science Center (MSC) The
SPMDs were processed as previously described (Petty, et.al.,
1993); and forwarded to the Patuxent Analytical Control Facility
for analysis. As part of the quality control procedures, we
shipped two performance evaluation materials (PEM) (blind
samples) as part of the sample catalogue. These PEMs consisted
of 30 ug of each priority pollutant PAH in 5mL of hexane and 10
ug of Aroclor 1242, 1248, 1254, and 1260 in 5 mL of hexane. The
results of the analysis of these PEMs by the contract laboratory
are presented in Tables 1 and 2. In general, the results are
quite good. The value for aroclor 1248 is somewhat high (130%
recovery) but still acceptable. In the case of the PAHs, the

In addition to the PEMs, field blanks (one for each site), a laboratory process blank, and an SPMD control were provided as part of the sample set. With the exception of HCB which is a MSC laboratory contaminant, no blank sample contained residue greater than the stated detection limits of the contract laboratory (i.e. 0.25 ug/g for PAHs and 0.004 ug/g for PCBs and OCs).

Based upon the results of the analysis of PEMs and the blanks, we believe the samples were deployed, retrieved, processed, and analyzed without introducing extraneous contamination.

Consequently, the SPMD sample data appear to be representative and acceptable.

SPMD Samples

The analysis of the 5 SPMD samples from Chisik Island revealed anthropogenetic contaminants to be present in only one sample.

The residues; benzo(a)pyrene (0.35 ug), benzo(b)fluoranthene (0.28 ug), benzo(e)pyrene (0.30 ug), benzo(k)fluoranthene (0.30 ug), and perylene (0.39 ug) were all very low and near the stated detection limit. Further, only one of 5 samples contained detectable residues. Consequently, the Chisik Island site does not appear to have been impacted by PAHs or other anthropogenic contaminants during the exposure period.

The results of the analysis of SPMDs deployed at the Anchorage site are presented in Table 3. In contrast to the Chisik Island

site, contaminant residues were present in all 5 SPMD samplers. Alpha-BHC and gamma-BHC were present in 4 of 5 samplers with a mean value of 0.010 ug/SPMD and 0.017 ug/SPMD, respectively. N_0 PCB residues were detected in these samples. The PAH values presented in Table 3 are somewhat variable (RSD ranging from 24 to 37%) but appear to be verify the presence of PAH residues. Moreover, the residue found in these SPMDs are indicative of bioavailable residues (i.e. by respiration).

CONCLUSIONS

The data from this study demonstrate the utility of SPMDs to sequester airborne anthropogenic contaminants. Further, the SPMDs were successfully used to define the absence of detectable airborne contaminants on Chisik Island and the presence of typical anthropogenic contaminants in the air at the Anchorage site. Thus, the SPMD technique can be employed in ambient air monitoring activities.

Further research is required to develop the algorithm(s) necessary to estimate actual air concentrations. This research would involve controlled laboratory studies to define the kinetics of uptake of contaminants by SPMDs and additional field deployment of the SPMDs.

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able 1

	7.6	Recovery of Priority Pollutant Hydrocarbons - Performance Eval		cyc.	lic Aromatic Material	tic
РАН		Spike Level (ug/SPMD)	Recovery (ug/SPMD)	ary MD)	2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	(æ)
Naphthalene		30.	21			7.0
Acenaphthglene		30%	29		- 12 14 14 14 14 14 14 14 14 14 14 14 14 14	97.
Acenaphthene	10 April 10	人。60年2月6年時第30時時間			1.1 1.1 1.1 1.1 1.1	80
Fluorene	4	30	MH 1 1 26	李 罗尔·马科	10000000000000000000000000000000000000	87
Phenanthrene	· · · · · · · · · · · · · · · · · · ·	1 30 m	建剂制料			80
Anthacene	10000000000000000000000000000000000000	THE SOUND IN	1 26	15	发展 第二次	*87.34KE.
Fluoranthene	操作	中心。	10 1 1 1 1 2 2 .		No.	73
Pyrene	(表) (表) (注)	下。	3.4			8.7
Benz (a) anthracene	Andrew Control	* (4) (4) (4) (4) (4) (4) (4) (4) (4) (4)	6 THE PART			
Chrysene		14 S. T. T. T. S. S. W. W. T. T. S.	A. Tarelli 1. 2.2			73
benzo(b)fluoranthene		4、1、14年的6月30年期	1 1 1 1 1 2 8			93
Benzo(k)fluoranthene		2000年1月1日	27			06
Benzo(a)pyrene		30	28			93
Indeno (1, 2, 3, -c, d) pyrene		30 Kirling	NA		(A)	NA
Dibenz (a, h) anthracene	17	14.00年12.00年	22			73
Benzo(g,h,i)perylene	等。 第	7. S. J. W. 30	61		416	63

NA = Component not analyzed for in sample.

	Recovery of Pol Performance Eva	ychorinated Biphe luation Material	enyls -
, PCB	Spike Level :	Recovery (ug/SPMD)	(%)
1242	10	9.9	99
1248	10 171	13	130
1254	10	1 12	120
1260 5-	10	9.3	93

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	Residue	Found ir	SPMDs FI	Residues Found in SPMDs From Positive Contaol Site ug/SPMD	ve Contao	1 Site no	1/SPMD1	
Analyte	Site 1 - 1	Site 1 - 2	Site 1 - 3	Site 1 - 4	Site	×	S, D	RSD
Dibenz(a,h)anthracene	<0.25	<0.25₺₺₺	.<0∦25×#0.30	-0.30	0 39.	9.0		*
Alpha - BHC	0.009	<0.004	004年 李0世012年	. 0.010	800.0	20.0		
Benzo (a) pyrene	<0.25 ∴	0	34 and 10.45 and 0.60 Hz	0.50 ₩	8 9	0.00	0.0014	
Benzo(b)fluoranthene	0:30	0.35	€ 0:49	0.50		y 1.	0.12	24
Dona (a)			-		0000	C.4.0	0.12	27
penzo(e)pyrene	<0.25	<0.25	0.29	0.35	0.50	0.38	0.11	20
Benzo(k) fluoranthene	<0.25	0.30	< 0.47 < 0.35	0.35	0.63	0.44	31.0	3 3
Fluorene	<0.25	<0.25	<0.25	<0.25	0.30	0 30	CT.D	2.4
Gamma - BHC	0.015	<0:004	0.018	0.015	0.018	0.017	0 0013	1 0
Perylene	<0.25	<0.25	0.53	0.72		0 78	7.00.0	10

grams SPMD = 34 inches of polyethylent layflat tubing containing 1.0 mL triolein, 4.1